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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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IN THE HIGH COURT OF JUSTICE, CHANCERY DIVISION. 1917 N. 612.

Mr. JUSTICE YOUNGER.

In the Matter of THE NEW ROVER CYCLE COMPANY, LIMITED,

and

In the Matter of THE COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that a Petition was on the 17th February, 1917, presented to the High Court of Justice by the above-named Company to confirm an alteration of the said Company's objects proposed to be effected by a special resolution of the Company duly passed at an Extraordinary General Meeting of the said Company, held on the 23rd January, 1917, and subsequently duly confirmed at an Extraordinary General Meeting of the said Company, held on the 13th February, 1917, and which resolution is as follows:—

That the Memorandum of Association of the Company be altered in manner following, that is to say:—

(A) By the omission from the 3rd and 4th lines of sub-clause (a) of Clause 3 of such Memorandum of the words "but excluding such Company's motor cycle business."

(B) By cancelling sub-clause (n) of Clause 3 of the said Memorandum and substituting therefor the following sub-clause, namely:—

(n) To establish and carry on:—

(I) The businesses of manufacturers of and dealers in cycles side cars, vehicles and carriages of all descriptions (other than motor cars) and the component parts thereof respectively.

(II) The trades or businesses of engineers, machinists, millwrights, wheelwrights, manufacturers of and dealers in India rubber, gutta percha or other elastic substances or materials, brass founders, coppersmiths, ironfounders, wire drawers, tube makers, saddlers, galvanisers, japanners, annealers, enamellers, electro-platers, packing case makers and printers.

(III) The businesses of manufacturers of and dealers in commodities and articles other than motor cars which can be conveniently dealt in or manufactured or used by the Company for the purpose of any business herein mentioned or likely to be required by customers of any such business.

(IV) Any other business whether manufacturing or otherwise which may seem to the Company capable of being carried on in connection with any of the Company's objects or calculated directly or indirectly to enhance the value of or render profitable any of the Company's property or rights.

AND NOTICE IS FURTHER GIVEN that the said Petition is directed to be heard before Mr. Justice SARGANT, at the Royal Courts of Justice, Strand, London, on Tuesday the 27th day of March, 1917, and any person interested in the said Company, whether as creditor or otherwise, desirous of opposing the making of an order for the confirmation of the said alteration under the above Act, may appear at the time of hearing by himself or his Counsel for the purpose, and he is required to give two clear days previous notice in writing of his intention so to appear, with the grounds of his objection, to the undersigned, the Solicitors of the said Company. A copy of the said Petition will be furnished to any such person requiring the same by the undersigned on payment of the regulated charge for the same.

Dated the 7th day of March, 1917.

FIELD, ROSCOE & CO.,
36, Lincolns Inn Fields, W.C.
Agents for PINSENT & CO.,
Birmingham,
Solicitors for the above-named Company. G 336

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TENDERS.

IN THE MATTER OF THE TRADING WITH THE ENEMY AMENDMENT ACT, 1916.

The PUBLIC TRUSTEE invites

Tenders for the Purchase of the Whole or any part of 119,660 Shares of £5 each, fully paid, in SIMMENS BROTHERS & COMPANY, LIMITED, vested in him as Custodian by an Order made by the Board of Trade, in pursuance of Section 4 of the Trading with the Enemy Amendment Act, 1916, and dated 9th August, 1916.

The issued capital of the Company consists of 120,000 Shares of £5 each, fully paid.

The purchasers, who must be British-born subjects, will be required to make a sworn Declaration as to nationality and freedom from foreign control on a form to be obtained from the Offices of the Public Trustee.

The purchasers will also be required to satisfy the Public Trustee as to their financial and technical ability to carry on the business of the Company as efficiently as heretofore, or otherwise to the satisfaction of the Government.

A report upon the Company's operations and affairs has been prepared by the Company, in conjunction with the Company's Auditors (Messrs. PRICE, WATERHOUSE & Co.), and with Messrs. TURQUAND, YOUNGS & Co. Copies of this report can be obtained, subject as hereinafter mentioned, together with copies of Company's accounts up to the 31st December, 1915, at the Offices of the Public Trustee, Kingsway, W.C. All applicants will be required to satisfy the Public Trustee as to any matter which he may think fit to investigate before copies of said report or accounts will be supplied.

Intending Tenderers who desire to inspect the property of the Company, should apply to the Public Trustee for an authority to do so.

Tenders must be delivered, sealed, to the Public Trustee, Kingsway, W.C., on or before Monday, the 2nd day of April, 1917, at Twelve o'clock Noon, and marked on the envelope, "Tender, Siemens Shares."

The Public Trustee does not bind himself to accept any Tender, and reserves to himself all rights in connection therewith.

Forms of Tender can be obtained from the PUBLIC TRUSTEE.

Dated this 9th day of February, 1917. G 160

C. J. STEWART, Public Trustee,
Custodian for England and Wales.

APPOINTMENTS OPEN.

Chief Rate Fixer Required by one of the largest firms in the Midlands manufacturing Internal Combustion Engines and Motor Cars. Must be capable of laying out processes and fixing rates to drawings; good organiser; take entire charge of department. Only highly experienced men of strong character and possessed of considerable tact need apply. Generous salary to right man. No application from men already engaged on Government work will be considered.—Send full particulars to your nearest EMPLOYMENT EXCHANGE, quoting reference No. A 2965. G 314

Works Superintendent or ASSISTANT WORKS MANAGER REQUIRED by large well-known firm, Government controlled, making large and small engines, repetition and general work. Applications will only be considered from experienced engineers thoroughly conversant with latest manufacturing methods and who have made good in every way in similar position in large works. Permanent position to right man. State age, experience, and salary required. No one employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE mentioning this Journal and A 2998. G 244

First-class Experienced ESTIMATOR WANTED by Government controlled works making large and small engines, repetition and general work; man with thorough practical knowledge of machining and fitting, &c., who could control rate-fixing, progress, and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience, and salary required. No one employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE mentioning this Journal and A 3007. G 245

Large Engineering Firm, Government controlled, REQUIRE the SERVICES of thoroughly experienced WORKS ENGINEER used to lay-out, erection, and complete equipment of up-to-date works; well versed in modern machining and manufacturing methods and the upkeep of plant for maximum output. Permanency to good man. State age, experience, and salary required. No one employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE mentioning this Journal and A 2999. G 246

Electrical Engineer Required to take full control of all electrical installations and upkeep in large Government controlled works (bulk of current from Corporation). Applications will only be considered from experienced men who have held similar positions with good records. State age, experience, and salary required. No one employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE mentioning this Journal and A 2996. G 247

Engineer Wanted as Premium Bonus Rate Fixer for Marine Shop on the Clyde. Liberal salary given to good technical man with experience of machine shop practice. State fully qualifications, age and salary. No one already on Government work need apply.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning No. A 3018. G 324

Chemist.—Thoroughly Qualified and experienced Steelworks CHEMIST WANTED. Highest grade steels for projectiles, all classes of castings, tools, dies, ball-bearings. State particulars of experience, age, present employment and salary expected. No one already on Government work need apply.—Apply, your nearest EMPLOYMENT LABOUR EXCHANGE, mentioning No. G 326

Wanted, Works Manager, with practical experience for small general and agricultural engineering works in County Durham.—Address, stating age, experience, salary required, and giving references, G 309, Offices of ENGINEERING.

Wanted, Good Plant DRAUGHTSMAN, for London district, used to laying out machine and metal working shops. Good prospects to right man. No one resident more than 10 miles away nor employed on Government work will be engaged.—Address, stating experience, age, and salary required, G 314, Offices of ENGINEERING.

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Wanted, Draughtsmen for Jig, Tool, and General Design Work on Aeroplane Engines. Men used to motor car or high-class small engineering work preferred. No person already on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning No. A 2983. G 275

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Draughtsman Wanted for a National Factory in South Yorkshire. Must be experienced and well qualified.

Applicants already employed on Government work will not be engaged. Must be ineligible for the Army.—Address, stating age, experience, and salary required to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and G 274.

Mechanical Draughtsmen, WANTED IMMEDIATELY, for a Government-Controlled Aircraft Works in South-West of England. Aircraft experience desirable, but not essential. No person already on Government work will be engaged.—Apply, giving full particulars as to training, age, salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A2940. G 196

Plant Draughtsmen Required immediately for Government Factory. Good experience of general engineering and structural work essential. No man on Government work or eligible for Military service need apply.—Write or apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3010. G 296

Draughtsmen for Jigs and Tools, with shop experience; permanent positions. No man on Government work will be engaged.—Reply, stating qualifications, age, salary required, and earliest date can commence, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3003. G 207

Draughtsmen, Electrical, for Designs for A.—C. and D.—C. Machines. Those with good shop experience preferred. No man on Government work will be engaged.—Apply, stating qualifications, age, salary required, and earliest date can commence, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3004. G 208

Required, at Once, Two or THREE competent JIG and TOOL DRAUGHTSMEN. None but fully qualified men need apply. No one on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and G 243.

Several Good Mechanical DRAUGHTSMEN REQUIRED, for Admiralty establishment. Accustomed to small high class work preferred. Salary according to ability.—State experience, age, and present position, to BOX 1001, care of Messrs. E. F. WHITE & SON, Genl. Advng. Agents, 35, Fleet Street, E.C. G 261

Wanted, Assistant Chief Tool DRAUGHTSMAN for Aero Engines; also Draughtsman. London, N.W. State age, experience and salary expected. Those beyond a ten mile radius or on Government work need not apply.—Address, G 303, Offices of ENGINEERING.

Wanted, a Machine Shop FOREMAN in Government Controlled Establishment in Midlands, engaged on locomotive and general engineering work. Applicants should possess a good all-round knowledge of machine shop practice, piecework, and be capable of controlling 50 men. Permanent and good salary to first-class man.—Apply, your nearest LABOUR EXCHANGE, mentioning No. A2972. G 239

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THE LATE MR. JAMES FORREST.

MANY hundreds of engineers outside this realm, in addition to thousands at home, will hear with regret of the death of Mr. James Forrest. His decease is not a matter for active grief, however, for he died full of years after a life of splendid activity in which he had earned more kindly esteem and personal recognition than falls to the lot of one man in ten thousand. To many of the younger members of our profession he is little more than a tradition, for he spent the last twenty-one years in retirement at St. Leonards-on-Sea. But by those who are older it is recognised that among the men who were active in raising the status of engineering to its present position he was one of the principal. It was the ambition of his life to make the Institution of Civil Engineers the premier professional society of the world, and in so doing to obtain public appreciation of the fact that the engineer is not only the author and source of our material civilization, but that he has added greatly to our intellectual progress by substituting machinery for manual labour, and so affording men leisure to pursue art, philosophy, and science to an extent which is impossible in a community in which the immediate demands of daily life engross all the attention. He succeeded to an extent to which few men attain, and could look back on a long career of useful effort marked by constant progress, a steady advance which has continued under the care of his successor, Dr. Tudsbery, and of which the force is yet maintained. Mr. Forrest was in his 92nd year when he died last Friday. Ten years ago, on his 82nd birthday, the portrait was taken which we publish on this page, and many will recognise that it reproduces the pose shown in the oil painting which hangs in the Institution House as a permanent memorial of Mr. Forrest's work and of the great esteem in which he was held by the council and by all engineers who take a pride in their profession and in vindicating its claims to be the most important of all the learned callings. Those who have never met the original will see in the presentment the marks of a keen intellect and a strenuous and somewhat imperious will, tempered with a very large measure of human kindness, the latter being as important an agent as the former in the success attending Mr. Forrest's life-work.

Yours sincerely
James Forrest

James Forrest was born on November 30, 1825. In his sixteenth year he was articled to Messrs. Edward and John Manby, civil engineers, in Westminster; and on their removing their business shortly afterwards to Paris he was transferred, in 1842, to Mr. Charles Manby, then secretary of the Institution of Civil Engineers. During the three years ended in 1848 he acquired experience in field work on the Leeds and Dewsbury Railway, the Leeds and Thirsk, the East and West Yorkshire, and other railways in course of construction or extension. He then assisted Mr. Charles Manby at the Institution of Civil Engineers till 1852, when he became assistant secretary to the Society of Arts under Mr. (afterwards Sir) George Grove, who, on being appointed in the following year to the secretaryship of the Crystal Palace, Sydenham, was succeeded in his secretarial duties by Mr. Peter Le Neve Foster.

On Mr. Manby's retirement in 1856 from the secretaryship of the Institution of Civil Engineers Mr. Forrest returned to the Institution, and in June of that year was appointed virtually secretary, though nominally assistant secretary, until the proper title of secretary was accorded him in 1860. The Institution soon began to experience the advantage of having a secretary whose whole time and thought were devoted to the duties of his post, apart from all other interests. At that period the publication of the Minutes of Proceedings was limited to a single annual volume of about 500 pages. In the session 1869–70 two volumes first appeared; and five years later, in 1874–5, the number was increased to four volumes a year, which have been continued ever since, and have gradually grown in size until each nearly equals the former solitary annual volume. The issue of the four volumes was contemporaneous with the enlargement of their scope by the addition of abstracts from foreign scientific transactions and periodicals. During Mr. Forrest's tenure of the secretaryship the number of names on the roll of the Institution rose from between 800 and 900 to 6,900, the last number being inclusive of the added class of Students; and the annual income grew from 3,000*l.* to over 20,000*l.*

In token of the esteem in which he was held, his portrait, painted for the council by Mr. William M. Palin, was by them presented to the Institution on November 11, 1890. In making the presentation the President, Sir John Coode, said the council had felt how invaluable had been the services rendered to the Institution by the secretary; only those who had sat at the council table could form anything approaching a correct idea of his services; and only the president and past-presidents could entertain a truly adequate conception of the manner in which he fulfilled his duties.

In order to perpetuate the memory of his long services in the interests of the Institution an endowment fund was raised among the members generally in 1891, and in accordance with his wish was devoted to the foundation of a "James Forrest Lectureship." As thereby provided, a lecture dealing with the relation which one or other of the various branches of science bears to engineering has been delivered annually from 1893.

His retirement in 1896 from the post of secretary was referred to in the following words by Sir John Wolfe Barry, in his inaugural address as president on November 3, 1896:—

"Mr. Forrest has been connected with the Institution for 54 years, and has been assistant secretary or secretary for 40 years. He has known all the presidents with the exception only of Telford, and has seen almost the whole of the remarkable rise of the Institution in numbers, wealth, and position. . . . When he became assistant secretary in 1856 the Institution was considerably in

debt, although the publication of the Proceedings was in arrear. Now we publish four expensive volumes yearly, give copies to many kindred bodies, and discharge all our liabilities. . . . Very much of this management has been due to the sagacity and devotion of Mr. Forrest. It may truly be said of him that he has not only watched over the interests of the Institution with the greatest assiduity and with complete success, but that his office has been to him a labour of love. Certainly no man ever devoted himself more thoroughly heart and soul to his work than has Mr. Forrest from first to last during his long tenure of office."

The interest he took in the class of Students of the Institution—a class established during his secretaryship in 1867—led him to found in 1897 the "James Forrest" medal, to be awarded annually to the writer of the best Student's paper.

Alike on both sides of the Atlantic are there kindred societies, whose members cherish a most grateful remembrance of the courtesies and attentions they met with at his hands on the occasion of their several meetings held within the ever-hospitable walls of the Institution of Civil Engineers. It is true that in all he did for them he was but giving effect to the generous wishes of his president and council. At the same time this was done in no perfunctory manner; but he threw himself with such whole-hearted energy and such evident zest into the business of welcoming the several visitors that they one and all felt he was looking after their interests as keenly and as cordially as if he had no other duties to attend to; and naturally the spirit he so manifested could never fail to permeate the whole of the staff under his direction. Accordingly, he was the recipient at different times of various articles of plate as tokens of regard: from members of the American Societies of Mechanical Engineers and Civil Engineers in 1889, and again in 1896; from the Iron and Steel Institute in 1894; and from the Institution of Mechanical Engineers in 1897. The last of these presentations bore the inscription:—"Presented by the Institution of Mechanical Engineers to James Forrest in grateful acknowledgment of his unfailing courtesy and active kindness during nearly a quarter of a century, 1873–1896, as secretary of the Institution of Civil Engineers." Several, also, of the presidents of the Institution of Civil Engineers, having enjoyed so intimate a personal experience of the value of his services to themselves during their presidency, signified their appreciation by similar private presentations. Such testimonials were presented to him by Sir John Fowler, Mr. and Mrs. Thomas Hawksley, Mr. John Frederic Bateman, Sir Frederick Bramwell, and Sir George Berkley. His appointment as honorary secretary of the Institution on his retirement from the secretaryship was signalised at Christmas, 1896, by a presentation from "the past and present members of the council as a token of their sincere personal regard and as a mark of their high appreciation of the services rendered by him to the council during the forty years in which he acted as assistant secretary (1856–60) and secretary (1860–96) of the Institution." At the request of the council the very handsome collection thus accumulated from 1867 was exhibited in the Institution library on the occasion of the joint visit in 1900 of members of the two American Societies of Engineers, and was inspected with much interest and gratification by the visitors, as well as by the members of the Institution.

Where a secretary's principles and practice have throughout led him to sink his own personality in the conscientious and zealous discharge of his official duties, resolutely withstanding every temptation to self-glorification, it can hardly be wondered if his biography fails to record so many incidents as attach to the career of an engineer fulfilling a conspicuous public appointment, or with eminent success practising his profession on his own account. Thus it is that the present chronicle of so active and energetic a life as that of our honoured and faithful friend leaves those who have not enjoyed the privilege of knowing him personally to picture his individuality from the brief indications here attempted of what the Institution of Civil Engineers owes to the devoted services of James Forrest.

There was a large gathering of members of the Institution at a Memorial Service held at St. Margaret's Church, Westminster, on Wednesday morning last.

GERMANY'S COAL DEPOSITS.

THE war has raised the price of coal in all countries. In some it is costing 8*l.* to 10*l.* a ton, and adding largely to the outlay on the production of munitions. Under these circumstances the following survey, brought up to date, and giving many details about the coking qualities of German coal, will be of interest, although the rise in price in that country has not been excessive.

The main centre of the German coal-mining industry lies in the western part of the Empire, in the Ruhr, the West Rhenish, the Aachen and the Saar districts, which districts represent 70 per cent. of Germany's aggregate coal production, those of Silesia and Saxony accounting for the balance. In this article we deal with the western district of Germany, leaving the deposits of Silesia and Saxony for another occasion.

1. *The Coal Deposits in Westphalia and in the Lower Rhine (the Ruhr district).*—This coal-mining district extends from the Rhine some 80 to 90 km. in an eastern direction along the rivers Ruhr, Emscher and Lippe. Of late years the coal-bearing area of this district has been found to extend considerably in a northern direction, where the coal measures are covered with younger strata. This district may be divided into three zones—the pit zone, of 1,532 sq. km. (515 sq. miles); the borehole zone, of 1,728 sq. km. (660 sq. miles); and the, so far, non-investigated zone, of 2,910 sq. km. The vertical range of the coal measures amounts to 2,946 m. (9,700 ft.). The aggregate depth of the coal beds is 79.6 m. (262 ft.), distributed over 92 seams or beds.

The two tables appended contain some particulars about the distribution of the different kinds of coal and the vertical range of the coal measures in the district:—

The Capacity of the Coal-carrying Strata in Westphalia.

Type of Coal.	The Thickness of the Coal Measures.	The Thickness of the Coal Beds.	Number of Seams.
	m.	m.	
Lean coal	1,100	12.0	14
Fat coal	610	26.6	31
Gas coal	706	29.4	33
Gas-flame coal	530	11.6	14

THE CAPACITY, IN TONS, OF COAL IN THE RUHR DISTRICT DEPOSITS.

	Gas-flame Coal.	Gas Coal.	Fat Coal.	Lean Coal.	Total.
The pit zone	1,013,000,000	11,101,000,000	22,483,000,000	21,977,000,000	56,574,000,000
The borehole zone	5,726,000,000	25,253,000,000	26,086,00,0000	11,657,000,000	68,722,000,000
The non-investigated zone	22,500,000,000		66,000,000,000		88,500,000,000
					213,796,000,000

BY-PRODUCTS FROM COKE MADE IN THE RUHR DISTRICT.

—	(1) Per cent.	(2) Per cent.	(3) Per cent.	(4) Per cent.	(5) Per cent.	(6) Per cent.	(7) Per cent.	(8) Per cent.	(9) Per cent.	(10) Per cent.	(11) Per cent.	(12) Per cent.	(13) Per cent.	(14) Per cent.	(15) Per cent.
Coke	83.0	80.0	80.0	80.0	79.0	79.0	79.0	78.0	76.0	76.0	75.5	74.0	74.0	74.0	72.0
Ash in coke	8.5	8.4	7.95	9.0	8.2	8.75	8.9	8.6	8.7	8.5	8.6	9.0	8.54	8.5	8.6
Tar	1.3	1.95	1.97	1.7	3.05	3.25	2.2	3.0	3.41	3.0	3.15	3.70	3.6	2.8	3.88
Sulphate of ammonia	0.9	1.10	1.10	1.1	1.28	1.20	1.9	1.3	1.36	1.28	1.26	1.30	1.35	1.3	1.38
Benzol	0.5	0.43	0.45	0.6	0.67	0.70	0.5	0.45	0.51	0.65	0.48	0.75	0.70	0.9	0.78

This total of about 214,000,000,000 tons, at the present production of the district of about 107,000,000 tons per annum, should suffice for about 2,000 years, if it were feasible to work at the greater depths indicated, and if all the coal were worth bringing to the surface.

The lean Westphalian coals are generally poor in gas and do not yield a firm coke, but only a loose powder, and the gas generated from them has but small illuminating power. The fat coal belongs either to the old class, poor in gas, or to the younger, rich in gas, and lends itself admirably to the production of coke. Coke manufactured from it has the typical porous appearance, while the gas burns and produces soot. The gas coal, on the other hand, yields a somewhat porous coke which, with higher percentages of gas, looks compact, but is full of cracks and is non-porous. This class of coal, too, produces a gas which gives good light and a considerable amount of soot. The gas-flame coal will not agglomerate in the coking oven and only produces a loose coke. The gas burns with a long, dark red-yellow, luminous flame, very productive of soot. The coking quality of the coal increases with the depth. The fat coal first increases in coking quality with the depth of the bed and then decreases, The percentage of gas in the different layers diminishes by degrees from the hanging to the lying strata, and increases in the same layer from west to east, so that the same seam may contain coking coal in the east and lean coal in the west.

The percentage of gas is as follows; the higher figures in the percentage refer to washed coal:—

	Percentage of Gas.
1. Lean coal—	
(*a*) Anthracite	4 to 6
(*b*) Lean coal	6 to 12
(*c*) Smiths' coal	12 to 18
2. Fat coal—	
(*a*) Half-fat coal	18 to 20
(*b*) Fully fat coal	20 to 24
3. Gas coal—	
(*a*) Fat-flame coal	24 to 28
(*b*) Gas coal	28 to 32
4. Gas-flame coal	30 to 40

The respective quantities of coal used for the production of coke in the Ruhr district in the year 1904 were:—

	Tons.	Per cent.
Fat coal	10,425,000	95.48
Fat-flame coal	200,000	1.83
Smiths' coal	293,000	2.69
Total	10,918,000	

And for the year 1910:—

	Tons.	Per cent.
Fat coal	13,506,000	93.43
Fat-flame coal	734,000	5.08
Smiths' coal	216,000	1.49
Total	14,456,000	

The use of smiths' coal for the production of coke has evidently decreased both relatively and absolutely, the fat-flame coal, which is richer in gas, being used to an increased extent. This fact may be attributed to the constantly increasing interest taken in the auxiliary products from the coke ovens. As to the by-products from the coke production in the Ruhr district, the third table annexed contains a number of particulars. In most cases the benzol is cleansed.

2. *The West Rhenish Coal Basin*, or the North Crefeld deposit, forms the direct continuation of the Ruhr basin and is only geographically divided from the latter by the valley of the Rhine. The seams laid bare comprise the whole group of fat coal and part of the lean coal, besides gas coal and gas-flame coal. The depth and the percentage of gas of the different seams, however, are considerably smaller than those of the corresponding seams in the Westphalian basin.

The aggregate depth of the measures carrying lean coal amounts to about 1,200 m., with about 9.6 m. (31 ft. 6 in.) of coal in 13 seams. The aggregate depth of the fat coal measures is about 520 m., with 14 seams of coal having an aggregate thickness of coal of 14 m. (46 ft.). In the gas coal group a thickness of about 340 m., with 7 m. (23 ft.) of coal in 7 seams, is reckoned upon; and of the gas-flame group so far only the lower 100 m. have been opened up, with a coal seam of 1.2 m. (4 ft.)

capacity. The aggregate quantities of coal in this district down to 1,200 m. depth amount to 7,100,000,000 tons, divided amongst the different kinds of coal as follows:—

	Tons.
Gas-flame coal	14,000,000
Gas coal	338,000,000
Coke coal (fat coal)	3,200,000,000
Lean coal	3,548,000,000
Total	7,100,000,000

With the present production of 3,700,000 tons per annum, the coal of this district would last for some 1,900 years.

The percentage of gas in the coal increases in the whole district towards the hanging wall of the formation. In the same seam the gas percentage increases towards the north. This variation in gas percentage does not depend upon the bulk of the strata above, but upon an original difference in gas percentage, connected with the primary formation of the coal, a phenomenon also to be observed in Upper Silesia and in the Ruhr basin.

Distillation products from coal from the West Rhenish district are as follow:—

	Per cent. (1)	Per cent. (2)
Coke	80.0	77.0
Ash in coke	8.0	7.0
Tar	3.4	2.9
Sulphate of ammonia ...	1.3	1.2
Benzol	0.7	0.41

The first figure for benzol refers to cleansed benzol.

3. *The Brüggen-Erkeleng District* is situated south of Crefeld Sattel Horst. These deposits contain anthracite coal with from 6 to 10 per cent. of volatile substances. Otherwise most of the coal in this locality contains 10 to 15 per cent. of gas, equal to the best Cardiff coal; the highest percentage of gas in this district is 18 per cent. The western portion (Horst von Wassenberg) has an area of 14 sq. km. (5.4 sq. miles), with at least 1 m. of coal to about 400 m. of depth, which comes out at about 14,000,000 tons of coal. The Horst von Brüggen and the Erkeleng district comprise an area of 212.6 sq. km. (83 sq. miles). Down to 700 m. (2,300 ft.) depth, 8 m. (26¼ ft.) of coal have been proved, which comes out at 1,732,000,000 tons of coal. The Brüggen-Erkeleng district is separated from the Aachen basin by the Roertalgraben, a district which, so far, has been but little examined, but which probably will augment the West Rhenish coal deposits to a not inconsiderable extent.

4. *The Aachen Basin.*—This district consists of two smaller basins, viz., the Inde basin, east of Aachen, and the Wurm basin, north of Aachen, geologically divided by the Aachen saddle.

According to the Krusch investigations the lean coal measures of the Aachen basin have a depth of about 380 m., with 15 m. (49 ft.) of coal, the figures for the flame coal group being respectively 200 m. (656 ft.) and 3 m. (11 ft.), for the coking coal group respectively 300 m. and 5.5 m. (18 ft.), and for the gas coal group respectively 250 m. and 3 m. (10 ft.). The area of the coal-bearing district is 2,500 sq. km. (970 sq. miles), and the quantity of coal to a depth of 1,000 m. is estimated at 1,567,000,000 tons. With the present production of some 3,000,000 tons these deposits would thus suffice for another 500 years. The upper seams contain excellent coking coal, which yields 68 to 74 per cent. of coke, whilst the lower seams are more of the flame-coal type, with 74 to 82 per cent. of coke.

The Wurm basin extends in the western direction to the Limburg basin, from which it is divided by a saddle formation, which forms the frontier between Germany and France at Herzogenrath and Kirchrath. The Wurm basin, in its western portion, contains semi-anthracite lean coal, with 6.5 to 11.8 per cent. of volatile substances. This strikingly low percentage of gas is attributed to secondary geological conditions. The lean coal from this district consequently does not correspond in its genesis with the lean coal of the Ruhr district, but has more in common with this latter district's smiths' coal or fat coal. Similarly to the Ruhr coal, the coal of the eastern portion of the Wurm basin contains more gas than that of the western. In the upper seams there is fat coal with 18 to 22 per cent. of volatile substances, and in the lower flame coal with 15 to 19 per cent.

The appended table shows the distillation products of the Aachen coal:—

	(1) Per cent.	(2) Per cent.	(3) Per cent.
Coke	78.0	82.0	83.0
Ash of coke	10.5	10.5	9.0
Tar	2.0	1.7	1.7
Sulphate of ammonium ..	1.05	1.05	1.05
Benzol	0.3	0.3	—

5. *The Saar District.*—The coal deposits in the Saar district belong principally to the Prussian State, but the deposits also extend into Bavaria and France. The coal is located at a greater depth in the west than in the east. Whilst coal, for instance, at Kleinrosseln is come upon at a depth of 75 m., it is at a depth of 462 m. at Bolchen, of 590 m. at Falckenberg, and of 896 m. at Abbancourt in France. The capacity of the Saar coal deposits is calculated at 16,548,000,000 tons, of which fat coal accounts for 8,299,000,000 tons and flame and lean coal for 7,316,000,000 tons and 933,000,000 tons respectively. With the present production of 17,000,000 tons a year the Saar coal deposits would thus last about 1,000 years. Their quality depends upon their location in the different groups of the coal measures. In the lower Ottweiler measures lean coal seams are come upon, and flame coal and fat coal in the Saarbrücken seams. The gas percentage increases with the depth. The names are a little misleading; the so-called lean coal is not poor in gas, but is, on the contrary, rich in gas, and shows, in addition, the smallest percentage of carbon in the Saar coal deposits. The fat coal of the Saar district is more like the Westphalian fat flame coal, at least as far as the older Saar district is concerned. The gas here amounts to 25 to 28 per cent. In Lorraine the gas percentage of the fat coal rises above 30 per cent., which even corresponds with the Westphalian gas-flame coal. So as to increase the yield of coke in the Saar district, as much as 20 per cent. Westphalian lean coal is added in coking. Also the lower flame coal in the deeper strata of some parts lends itself to coking, mostly, however, it is non-coking coal; whilst the upper flame coal mostly turns out as sand coal. All the Saar coal, in order to yield a solid coke, must be crushed. The following tables contain some particulars of the Saar coal:—

THE COAL DEPOSITS OF THE SAAR DISTRICT.

—	The Western Field.			The Central Field.			The Eastern Field.		
	The Thickness of the Coal-carrying Strata.	Beds Worth Working. Number.	Beds Worth Working. The Thickness of the Coal-carrying Strata.	The Thickness of the Coal-carrying Strata.	Beds Worth Working. Number.	Beds Worth Working. The Thickness of the Coal-carrying Strata.	The Thickness of the Coal-carrying Strata.	Beds Worth Working. Number.	Beds Worth Working. The Thickness of the Coal-carrying Strata.
	m.		m	m.		m.	m.		m.
Upper flame-coal group..	813	7	8.30	584	8	8.57	381	9	13.74
Lower flame-coal group..	276	3	2.90	168	5	6.24	128	3	4.30
Fat coal group	1,399	22	31.42	1,293	24	28.13	1,022	15	19.67
Totals	2,488	32	42.62	2,045	37	42.94	1,531	27	37.71

The Carbon Percentages of the Saar Coal.

—	Raw Coal.	Picked Coal.	Contained Water.
	Per cent.	Per cent.	Per cent.
Lean coal	65.76	77.81	5.72
Upper flame coal.. ..	70.24	79.32	4.83
Lower flame coal.. ..	74.29	81.16	3.57
Fat coal	78.75	84.72	2.06

Distillation Productsof Coal from the Saar District.

	(1) Per cent.	(2) Per cent.	(3) Per cent.	(4) Per cent.
Coke	70.0	70.0	70.0	68.0
Ash of coke	11.5	11.5	11.20	11.0
Tar	4.15	3.75	3.6	4.0
Sulphate of ammonium ..	0.97	0.95	0.85	0.95
Benzol	0.7	0.9	1.09	1.00

In the year 1913 the coal production in Germany amounted to 192,000,000 tons; with this production the German coal mines should last, to the 1,000 m. depth, for some 750 years, to the 2,000 m. depth, if it should be found possible at some future time to work to such depth, even 2,100 years. As the subjoined table shows, the production has been constantly increasing, but it would be a very difficult, not to say an impossible, task to calculate how this increase of production will proceed for the future, inasmuch as a number of factors have to be reckoned with in this connection which defy calculation, such as the development of the mining technique, transport conditions, growth of population, labour, the state of the market, exploitation of foreign coal deposits, legislation, &c.

	Tons.	Increase Per cent.
1850	5,184,000	—
1860	12,384,000	138
1870	27,515,000	123
1880	45,896,000	67
1890	70,395,000	53
1900	106,468,000	52
1910	152,882,000	44
1913	191,511,000	25

A fact of special significance will appear from the subjoined table, which shows that Germany's coal and lignite deposits constitute more than half of the aggregate for Europe of these commodities. Compared with England, it is further worth noticing that the latter country, although her coal deposits do not amount to half of Germany's, annually produces 45 per cent. more coal than Germany.

The Coal and Lignite Deposits of Europe.

	Tons.	Per cent.
Germany	423,358,000,000	54.00
Great Britain and Ireland	189,533,000,000	24.17
European Russia ...	60,106,000,000	7.67
Austria-Hungary ...	59,269,000,000	7.56
France	17,583,000,000	2.24
Belgium	11,000,000,000	1.40
Spain	8,763,000,000	1.12
Spitzbergen ...	8,750,000,000	1.12
The Netherlands ...	4,402,000,000	0.56
Serbia	529,000,000	0.06
Bulgaria	388,000,000	0.04
Italy	243,000,000	0.03
Sweden	114,000,000	0.01
Denmark (Faröe Islands)	50,000,000	0.02
Greece	40,000,000	
Roumania	39,000,000	
Portugal	20,000,000	
Total	784,192,000,000	

THE LYONS FAIR.—According to *L'Exportateur Français*, the opening of the Lyons Fair has been delayed to the 18th inst. It was to open on the 1st inst., and the installations would have been ready in good time. Owing, however, to the persistence of the cold weather, many articles and samples could not have reached Lyons in time, and the committee decided to postpone the date of opening. Over 2,500 exhibitors, of whom 300 are foreign, are taking part in the display. The total number is four times greater than the figure for last year. The Fair will close on April 1.

THE PANAMA CANAL COALING PLANTS.—Several ledges of hard coral and blue rock in the channel leading to the coaling plant at Cristobal, says *The Panama Canal Record*, are being taken out by the 15-yard dipper dredge Gamboa. These were left at the time the original channel was excavated by smaller dredges, and the improved condition in the Cut has made it feasible to transfer the Gamboa to this work. The removal of the ledges will widen the available channel considerably and expedite the handling of ships to and from the plant. The Cristobal and Balboa coaling plants have together a total emergency storage capacity of 700,000 tons. Their normal storage capacity will be approximately 500,000 tons; of this, 350,000 tons will be at Cristobal, and it is expected that most of the coaling will be done at the Atlantic terminus.

THE "WELLMAN" FURNACES.

CONSTRUCTED BY MESSRS. WELLMAN, SEAVER AND HEAD, LIMITED, ENGINEERS, LONDON.

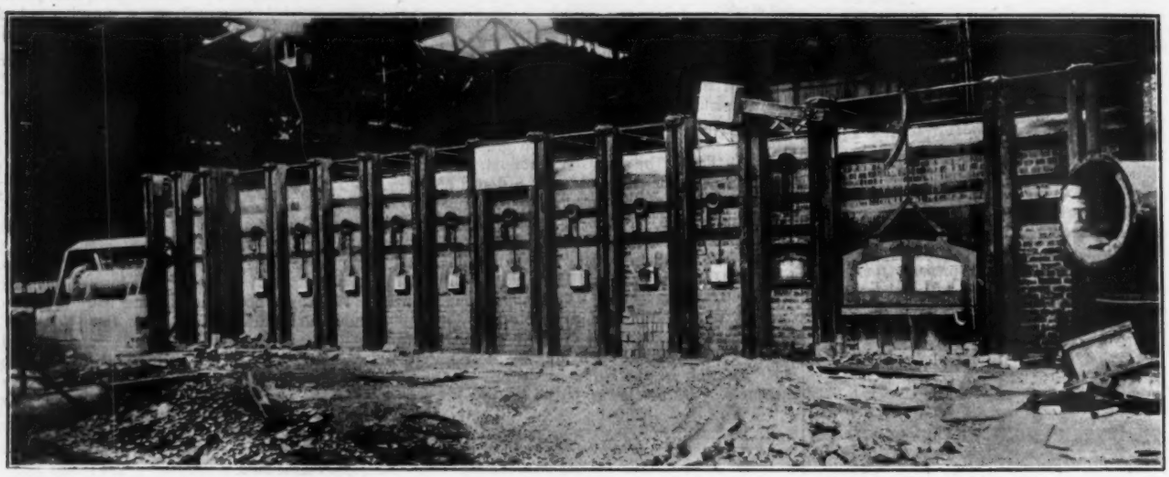
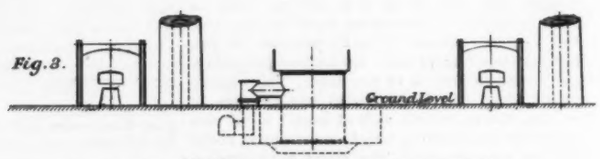
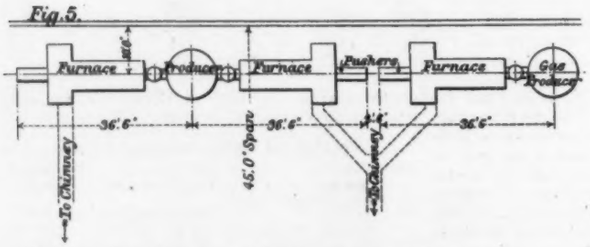
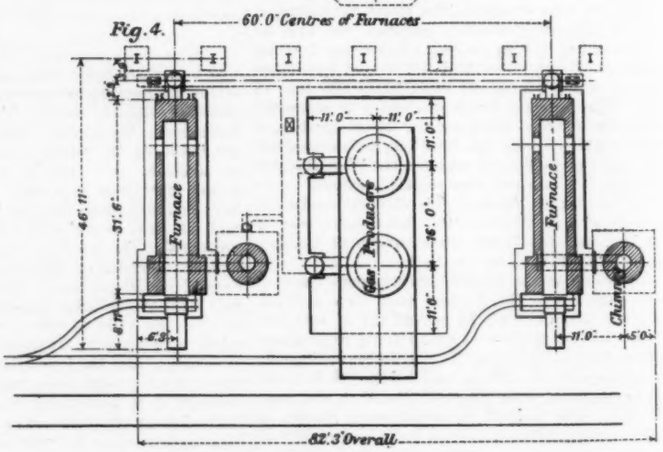


FIG. 1.



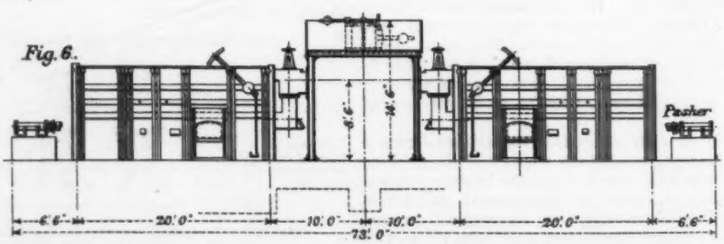


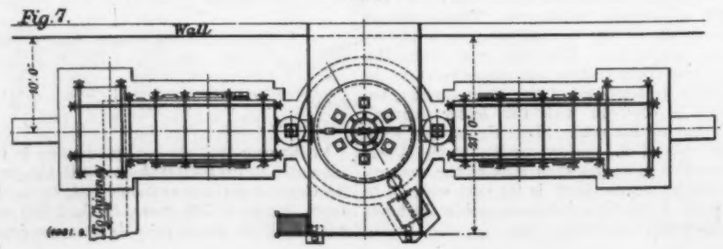


WE illustrate in Figs. 1 to 15 on the present and opposite pages, a series of furnace installations built by Messrs. Wellman, Seaver and Head, Limited, King's House, Kingsway, for heating shell billets for punching and drawing, and also for heating ingots for rolling. Fig. 1 is an external view reproduced from a photograph, showing a "Wellman" furnace of 50 ft. interior length for pre-heating 3-ton ingots. The small view, Fig. 2, illustrates the arrangement followed for supplying coal to the gas producers for two shell billet reheating furnaces, whilst Figs. 3 and 4 show two such reheating furnaces for shells, the producers, as will be seen, being placed between the two furnaces.

The billets are brought on narrow-gauge cars to the charging end of the furnaces, and are pushed into and along the furnaces by means of hydraulic pushers, as described later. An arrangement of three furnaces in a line, with one gas producer supplying gas to two furnaces direct, and one producer supplying gas to the remaining furnace, is shown in Fig. 5, whilst Figs. 6 and 7 show the two furnaces taking their supply of gas from one gas producer.

Figs. 8 to 15, on page 219, are detailed sections through a "Wellman" furnace, a number of which have been put down for reheating various-sized shell billets. The novelty of this furnace is the method followed for pre-heating the air, and also the device for admitting the gas and air for combustion. The air is pre-heated by causing it to pass between narrow exhaust flues underneath the furnace hearth, and then to an annular flue between the furnace crown and exhaust flue running over the top, as shown in Figs. 8, 10 and 11. The gas producer is placed close to the furnace, and by this means the sensible heat of the gas is utilised; the temperature of the gas entering the furnace is about 1,250 deg. F. The air is pre-heated to this same temperature, so that an intense heat is obtained at the withdrawing hearth; the billets can easily be heated up to a welding, punching or rolling temperature. The furnace shown is 24 ft. in length, and when the billets reach the hearth they only require about two minutes' soaking before they are





THE "WELLMAN" FURNACES.

CONSTRUCTED BY MESSRS. WELLMAN, SEAVER AND HEAD, LIMITED, ENGINEERS, LONDON.

Fig. 8.

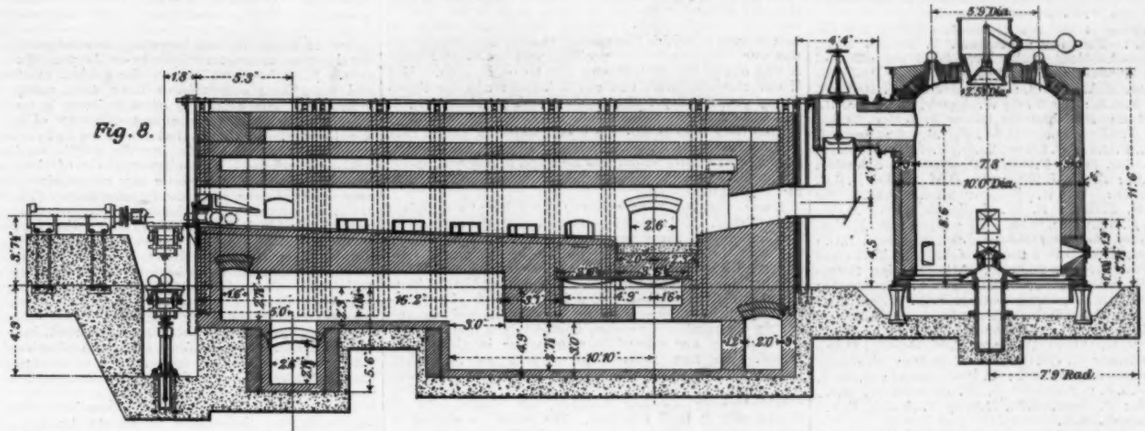


Fig. 9.

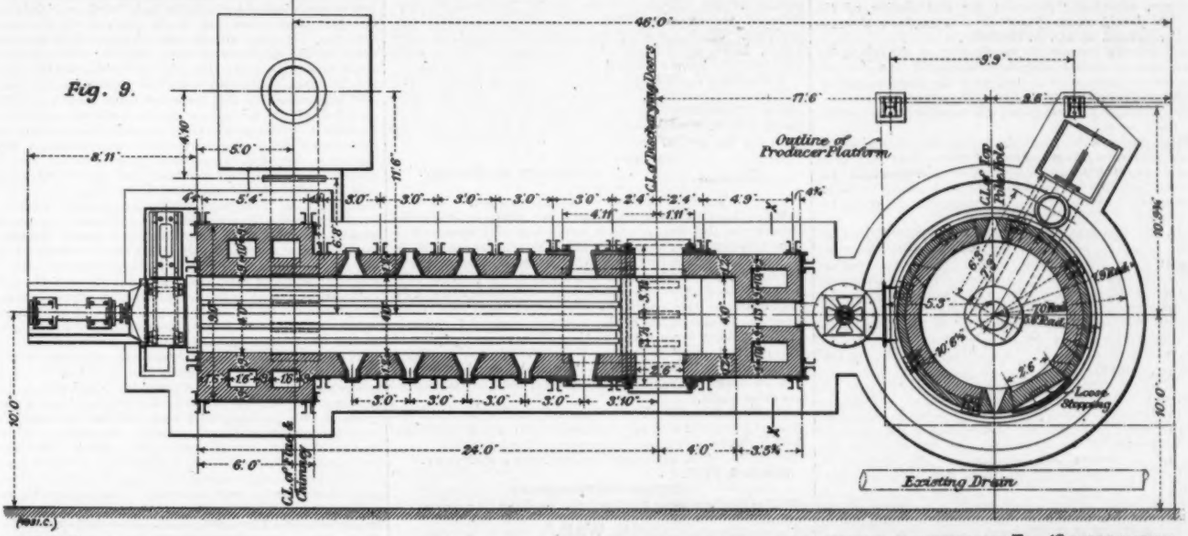


Fig. 10. SECTION THROUGH CHIMNEY FLUE.

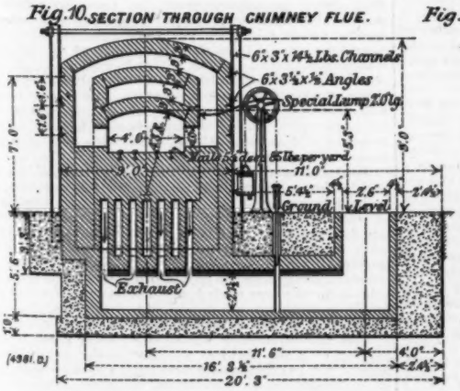


Fig. 11. SECTION THROUGH DISCHARGING DOORS.

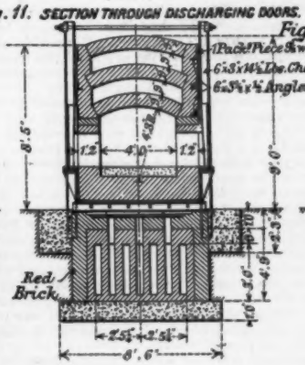


Fig. 12. VIEW LOOKING AT CHARGING DOOR.

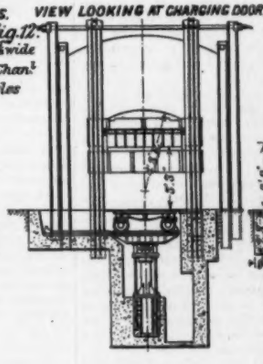


Fig. 13. SECTION AT X.X

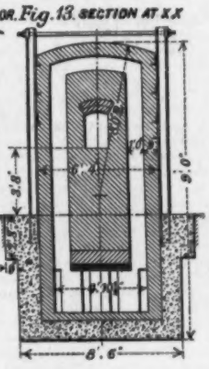


Fig. 14. SECTION AT GROUND LEVEL.

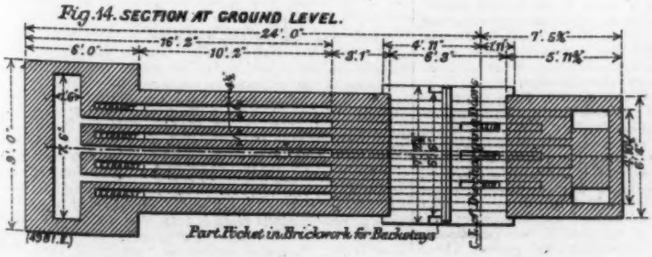
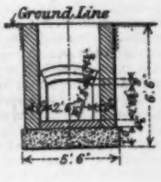


Fig. 15. SECTION AT CHIMNEY DAMPER.



ready for drawing. As will be seen from Fig. 8, the gas supply is controlled by a mushroom valve; the two air ports are regulated by dampers, so that any mixture can be obtained and the atmosphere of the furnace regulated at will. This furnace will heat 50 to 60 tons of medium-sized shell billets in 24 hours with a fuel consumption not exceeding 1½ cwt. per ton of billets.

The billets are delivered on a narrow-gauge bogie and run on the top of an hydraulic lift which raises them to the charging door fore-plate level (see Figs. 8, 9 and 12), when an horizontal hydraulic pusher comes into operation and pushes the billets into the furnace. The billets travel down the furnace in a double row and are drawn out by the two lateral discharging doors, shown in Fig. 9, and taken to hydraulic punching and drawing presses placed on both sides of the furnace. This type of furnace is also in operation for heating 20-cwt. ingots for direct rolling.

THE PHYSICAL SOCIETY OF LONDON.

At the annual general meeting, held on February 9, at the Imperial College of Science, Professor C. V. Boys, F.R.S., President, in the chair, the report of the council was read by Dr. W. Eccles, and adopted.

The following is the list of officers elected for the ensuing year:—President: Professor C. Vernon Boys, F.R.S. Vice-Presidents (who have filled the office of President): Professor G. C. Foster, F.R.S.; Professor R. B. Clifton, M.A., F.R.S.; Professor A. W. Reinold, C.B., M.A., F.R.S.; Sir W. de W. Abney, R.E., K.C.B., D.C.L., F.R.S.; Principal Sir Oliver J. Lodge, D.Sc., F.R.S.; R. T. Glazebrook, D.Sc., F.R.S.; Professor J. Perry, D.Sc., F.R.S.; C. Chree, Sc.D., F.R.S.; Professor H. L. Callendar, M.A., F.R.S.; Professor A. Schuster, Ph.D., F.R.S.; Sir J. J. Thomson, O.M., D.Sc., F.R.S. Vice-Presidents: W. R. Cooper, M.A., B.Sc.; Sir Napier Shaw, F.R.S.; S. W. J. Smith, M.A., D.Sc., F.R.S.; W. E. Sumpner, D.Sc. Secretaries: W. Eccles, D.Sc., Finsbury Technical College, Leonard-street, E.C.; R. S. Willows, M.A., D.Sc., the Sir John Cass Technical Institute, Jewry-street, Aldgate, E.C. Foreign Secretary: R. T. Glazebrook, D.Sc., F.R.S. Treasurer: W. Duddell, F.R.S., 56, Victoria-street, S.W. Librarian: S. W. J. Smith, M.A., D.Sc., F.R.S., Imperial College of Science and Technology. Other Members of Council: H. S. Allen, M.A., D.Sc.; Professor E. H. Barton, D.Sc., F.R.S.; Professor G. W. O. Howe, D.Sc.; Professor J. W. Nicholson, M.A., D.Sc.; C. C. Paterson; C. E. S. Phillips, F.R.S.E.; Professor O. W. Richardson, M.A., D.Sc., F.R.S.; S. Russ, M.A., D.Sc.; T. Smith, B.A.; F. J. W. Whipple, M.A.

A paper, entitled "*Note on the Calculation of the Coefficient of Diffusion of a Salt at a Definite Concentration*," was read by Dr. A. Griffiths.

In the calculation of the coefficient of diffusion, by B. W. Clack, a simple relation is assumed between the density of a solution of a salt and the concentration. This simple relation is only approximately correct, and compromises are made which require justification.

This note—

1. Suggests a method of calculating the coefficient of diffusion which, to a high degree of theoretical accuracy, gives values for the coefficient which are independent of a precise relationship between density and concentration.

2. Justifies the method of calculation adopted by B. W. Clack.

Mr. B. W. Clack pointed out that the coefficient of diffusion is not a constant, but varies with the concentration to a considerable extent. In most experimental work the coefficient varies at different positions in the apparatus, and any work which helps towards the proper interpretation of results is of value.

A paper, entitled "*A Special Test on the Gravitation Temperature Effect*," by Dr. P. E. Shaw and Mr. C. Hayes, was read, in the absence of the authors, by the assistant secretary.

In the Philosophical Transactions of the Royal Society, vol. cxvi, pages 349 to 392, there is a paper by one of the authors dealing with the possible existence of a temperature coefficient of the constant of gravitation. It was suggested in the discussion that the effect might be due to an inward displacement of the large lead spheres, at the higher temperatures, due to convection currents.

In the present paper experiments are described in which this point is tested by micrometric measurements of the positions of the supporting wires. It is shown that, at the higher temperatures, there is a small outward displacement of the spheres, probably due to the expansion of the crosshead from which they are suspended. A slightly higher value has, therefore, to be given to the temperature coefficient of gravitation.

Mr. F. E. Smith suggested that since it appeared to be necessary to measure the deflection of the large spheres in order to arrive at the correct result, this could be more advantageously done with an arrangement of microscopes than with the micrometers employed.

Professor C. V. Boys thought the subject was one of vital importance. He was not yet convinced that the results obtained by Dr. Shaw were necessarily true; but the apparatus was in many ways so beautifully designed that it was difficult to see what could give rise to the discrepancy. It seemed to him that Dr. Shaw's method of measuring the constant at two different temperatures was not the best way of measuring the difference between these values, which was thus subject to the inaccuracy of the complete determination. It seemed a better plan to have two sets of balls, one in the A position and one in the B position, and to measure any change in the deflection produced when one pair was hot and the other cold, and *vice versa*. This would be a null method, and would measure only the temperature coefficient if such existed. He had mentioned this to Dr. Shaw, who had brought forward some difficulty in connection with it which he could not at the moment remember.

Mr. C. C. Paterson asked if it was not possible for convection currents to be set up inside the vacuum tube and to affect the small spheres.

The reply of the authors will appear in the Proceedings.

GUTHRIE LECTURE.—The third Guthrie lecture will be delivered by Professor P. Langevin, at the Imperial College of Science, on Friday, March 23. The title of the lecture, which will be given in English, is "Molecular Orientation."

THE LATE MR. JAMES MAYNE NICHOLLS.—We regret to have to communicate the death, which occurred on Sunday last, the 4th inst., at 224, Cromwell-road, of Mr. James Mayne Nicholls, M.Inst.M.E., F.S.A., who was for 20 years the general manager of the Nitrate Railways, Iquique, Chili.

IMPERIAL PREFERENCE IN TRADE.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent who signs himself "A Student of Political Economy" is far from convincing. He asks what our position is likely to be in the world's markets if an Austrian twopenny pencil continues to be better than a British threepenny pencil, as it was before the war. Evidently our position will be exactly what it was before the war, at any rate to begin with. But if our manufacturers can get a home trade for threepenny pencils they will be able to enlarge their output, and in so doing to reduce their working costs, and after a time they may produce a good twopenny pencil that will compete with the Austrian product. That is the sequence of events which was followed in Austria, and it seems reasonable to assume that like causes will lead to like results here.

Economics, like many other subjects, is not a complete mental diet. To restrict one's self entirely to it is to risk atrophy in some part of the body politic. Before the war we were the only nation in the world that governed itself by the teaching of economics, and if the war had been deferred another 20 years we should have found ourselves helplessly bound in trammels of our own making. The article you recently published on the supply of tungsten shows how completely in one instance we had put our manufacturing power in Germany's hands. We had refused to protect an important industry, and consequently it had taken root elsewhere under more favourable conditions. Once it had been established in another country, all opportunity of introducing it here was lost. We stood no chance of selling in the markets of the world, because the first attempt would have been met with a ruinous competition. With our big home market we could, in a few years, have established the manufacture on a scale which would have rendered it able to take care of itself.

Economics teaches a nation how to buy cheaply, but it does not direct them how to live safely. We have just spent 2,000,000,000*l.* in extracting ourselves from dangers of which economics gave us no warning, and we have not yet got to the end of our expenditure.

Yours truly,

"A STUDENT OF HISTORY."

TO THE EDITOR OF ENGINEERING.

SIR,—As you have honoured me with an editorial remark on the letter which you so kindly inserted in your current issue, may I say that the reports sent to the late Lord Goschen by our British Ambassadors at Paris, Berne, Rome, Vienna and St. Petersburg proved conclusively, and therefore enabled me to realise fully, how disastrous to the countries concerned had been their attempts to use tariffs in the way you suggest?

We, "alone among the nations," have no surplus of any natural product (unless it be Welsh coals, steam and anthracite) with which to "protect" our industries; and we must, therefore, strive for an increase of brain-power in trade.

Tariffs or no tariffs, I most earnestly invite the attention of your good self and of your readers to my very simple case of the twopenny and threepenny lead pencils.

"A STUDENT OF POLITICAL ECONOMY."

March 6, 1917.

"ENGINEERING EDUCATION AFTER THE WAR."

TO THE EDITOR OF ENGINEERING.

SIR,—The excellent editorial in your issue of October 27, 1916, on "Engineering Education after the War," which did not come to my attention until quite recently, induces me to offer for your consideration a contribution to the pages of ENGINEERING.

Perhaps you might think it presumptuous on the part of an American engineer to express himself very plainly on the subject under consideration, were it not for the fact that I am a Scotchman by birth, a graduate of the University of Edinburgh, and served my pupilage to a member of the Institution of Civil Engineers in the old country. I have been engaged in the United States in engineering work for over thirty years, and in 1902 my *Alma Mater* conferred on me the degree of Doctor of Science on presentation of a thesis containing the results of original research on my part. With such plea as to my qualifications for seeking to address you, and with the assurance that under no circumstances could it be possible for me to obtain any personal preferment in offering the suggestions which follow, let me proceed, as one having many blood relations at the British front, to present my view of the case.

It is not until a British subject leaves his native heath, and begins to view his chosen life-work from the aspect of another country, especially a comparatively new one, that he realises his unwarranted inborn feeling of superiority to the rest of the world. Professor Fleeming Jenkin gave me some very good advice on my telling him I had decided to seek a career in the United States. His remark was "Do not be in too great a hurry to tell the Americans how much you know." Professor Jenkin, being intimately connected with submarine cable work, spoke whereof he knew, presumably because of his wide acquaintance with American scientific men.

It is characteristic of the British that they are essentially conservative *en masse*, despite protestations as to Liberalism and even Radicalism. Throughout my entire career I have not only studied deeply engineering as a science, but also I have been much interested in the development of technical education, not only in America, but in other parts of the world. It has appeared to me that the British have fallen behind Americans, at least in methods of practical education; not because of lack of initiative on the part of individuals, but principally because of the egotism of self-satisfied groups whose policy seems to be to crush immediately any suggestion from a comparatively unknown individual as to departure from the beaten track. Surely you will not object thus far to my plain talk when both you and such a recognised expert as Sir Trevor Dawson criticise adversely the system of education conducing to such characteristics.

As is pointed out so clearly in your editorial, the future of Great Britain is greatly dependent upon the development of greater efficiency on the part of technical men. Much has been said on the subject of efficiency, and sometimes comparisons have been made rather illogically. The efficiency of Americans is essentially individual, while the recognised efficiency of Germany is collective. In the United States an individual may present a progressive idea to the public on his own initiative, whereas it is characteristic of the German that he respectfully suggests any progressive ideas he may evolve to the recognised authorities. This liberty of initiative on the part of Americans has largely conduced to the kind of technical education that makes for progress in the scientific world; the vaunted efficiency of the Germans, on the other hand, consists principally of enforced utilitarian organisation, with repression of the individual. Individual efficiency without organised collective efficiency makes only sporadic progress; on the other hand, collective efficiency is only effective in promoting the scientific progress of the world in so far as the individuals controlling such organisations have master minds, and that such master minds are devoid of moral turpitude; such men, for instance, as your present Premier.

True advances in engineering science have been made principally by individuals of liberty loving peoples, where such individuals have had freedom of intellectual thought and have not been subject to paternalistic systems. It may not be out of place here to rehearse some of the developments of physical science, of which engineering presents the practical side, within the past two or three generations, and let those who care to do so add the names of the inventors and their nationalities, in proof of the foregoing statement; the writer, as an American of Scotch birth, is too modest to append personally such names and nationalities. Chronologically, the following developments may not be in proper sequence, and no doubt many others might be added:—the steam engine; the steamship; the locomotive; the telegraph; the submarine cable; the distribution of illuminating gas; the sewing machine; anæsthetics; steel manufacture; steel bridge and building construction; the telephone; electrical lighting; the electric railway; the gas engine; the automobile; wireless telegraphy and telephony; the infernal submarine boat; the aeroplane; methods of mental development of the deaf, mute and blind as exemplified by the wonderful Helen Keller. How many are the result of German initiative?

While I am a loyal American citizen, and most sincerely so, if only because of the fact that America has given me intellectual liberty, let me speak as one having nothing but British blood in his veins. Let us put our pride in our pockets and seek the best in the characteristics of other great nations. German methods of technical education are essentially eclectic; the Germans are great tabulators and statisticians; their methods of utilitarian organisation teaching them to observe and profit from useful development in other countries besides their own. While such methods may conduce to improvement of progressive ideas, it is *the method per se* that seems paramount with the German, while the pursuit of fatuous ideals interferes seriously with practical results which might be put to immediate use in the liberal arts, apart from those arts fostered by the ruling classes, whether such rulers be intelligent or unintelligent. America, on the other hand, is ever ready to try a new thing, and stock companies for the purpose of promoting half-developed ideas are perhaps too common when the interests of enthusiastic investors are considered; however, "Yankee notions" are often the stepping-stones to important developments.

American methods of teaching technics are admittedly still far from perfect, but none can dispute that they are eminently progressive. It is worthy of note that some of the brightest minds amongst American scientific men are devoted to the study of this momentous question; some officially as a matter of business and others from purely altruistic motives. This is apparent from the constant struggle on the part of professors in the technical schools to improve their courses of instruction and also by the numerous papers presented by prominent engineers advocating specific improvements in technical education.

This communication would be of little value in connection with the problem you have under consideration were it not to offer some general and specific suggestions as to future British educational methods, even if some of the suggestions contain a good-natured drive at British self-satisfaction; remembering the famous couplet of the Scotch bard:—

"Oh would some power the giftie gie us
To see oorsels as ithers see us."

Great financial centres like London, New York, Paris and Berlin develop, amongst certain classes of their population, an objectionable arrogance toward outlying portions of the empires or countries in which they are situated. I could drive hard enough at New York, Paris and Berlin, but the following suggestion is respectfully submitted for London consumption: Drop such expressions as "London and the Provinces," "England and her Colonies," &c., amongst scientific or otherwise highly-educated men. Such expressions are patronizing and add to the gaiety of nations, especially other nations. Let nepotism and favouritism be abolished in the selection of organisation leaders. It is monstrous to allow a knave or a fool to lead intelligent men, either in military or civil life. Germans are not all "rotters"; they, too,

might do well to think this over. Recently, a genial member of the British Parliament, visiting the States, referred frequently to "the policy of the English nation" as though the British Empire were a thing apart. He spoke of the "King of England." Why such limitation to King George, who has endeared himself to everyone having a spark of British soul in him during the present crisis? It is without disloyalty to my adopted country that I take the greatest pleasure, whenever opportunity presents itself, in singing "God Save the King," but his true appellation is not "King of England." Enough, however, of generalisation—we are all creatures of propinquity, and no doubt some of your readers might wish, and quite properly so, to paraphrase the retort of the old darky who, after patiently listening to a tirade on the part of his wife, remarked, "All them things you say I is, you is, an' mo' too." It would be well if we would all drop characteristics that savour of Prussianism, which is essentially the breeder of resentment, if not anarchistic tendencies; maximum efficiency cannot exist in such an atmosphere.

Believing the injection of American methods of education into the more or less classic methods of Great Britain would assist in formulating a solution of the problem involved in the consideration of "Engineering Education after the War," my specific suggestion is that some authorised authority in Great Britain select a commission (say, three in number) of prominent American scientific men, to study conditions as they exist to-day in the old country so as to recognise the merits and defects of the existing British technical educational system. Then let this commission return to the United States and make a special study of the same subject here, noting not only what exists, but also what is being proposed under the auspices of the present active movement toward the improvement of educational methods in America. While the evolution of any general theory of technical education could not be permitted to revolutionise affairs by too rapid an introduction, it would be well not to proceed too slowly, recognising the fact that standardisation of anything means stagnation, unless such standardisation is recognised as only a flexible expedient promoting stability of progressive movement. The work of such a commission should only be indicated on the broadest possible lines, and it should be required to make progress reports from time to time, indicating its findings, so that when an ultimate report is submitted, outlining in full detail a general scheme of technical education, the schools of the old country would be prepared for the suggested innovations.

The individual members of such a commission should not be chosen from among those having only experience in *teaching* engineering in America, because many of such professors might have horizons limited principally by the science of pedagogy, but from among those practising engineers who have at one time taught engineering in schools of recognised standing, and who have given evidence of their continued deep interest in the subject of technical education, while directing engineering work of public importance and magnitude. That there are such men in this country is evident from the numerous papers on educational matters written by practising engineers.

In conclusion, the writer desires it understood without question that he would not be eligible as a member of the proposed commission, and that his plain speaking is wholly born of his deep-rooted love for the Mother Country notwithstanding changed allegiance.

Yours respectfully,

JOHN LUNDIE, D.Sc., Edin.

New York City, February 17, 1917.

VULGAR *VERSUS* DECIMAL FRACTIONS.

TO THE EDITOR OF ENGINEERING.

SIR,—In the review of Mr. Clapham's "Arithmetic for Engineers," which appears in your impression for December 22, 1916, page 607, I find a characteristic glorification of decimal and depreciation of vulgar fractions, the affection for the latter being characterised as "pathetic," because decimals are simpler.

Defining the meaning of simple to be, simple as a mental concept, we can best determine which form of expression is the more simple by setting against one another a series of equivalents thus :—

$$\begin{aligned} \tfrac{1}{4} &= 0.25 \\ \tfrac{1}{8} &= 0.125 \\ \tfrac{1}{16} &= 0.0625 \\ \tfrac{1}{3} &= 0.333 + \\ \tfrac{1}{6} &= 0.1666 + \end{aligned}$$

Clearly the expressions at the left are simpler and clearer in their meanings than those at the right. Read some of them aloud, thus: one-sixteenth equals six hundred and twenty-five ten-thousandths. The former expression conveys to the mind a clear, tangible sense of value, which the latter does not, the situation being at its worst in the case of repeating decimals. There can be no clearer expression of fractional value than the words one-third, while the equivalent decimal form conveys no definite sense of value until it is reduced (instinctively in this case) to its vulgar-fractional equivalent.

When we seek the reason for this superior clearness of meaning of vulgar fractions, we find it to be chiefly in the fact that they are reduced to their lowest terms, while the decimals are not. In the cases of $\frac{1}{8} = 0.125$ and $\frac{1}{16} = 0.0625$ the numerators and (understood but not written) denominators of the decimal forms are respectively 125 and 625 times as large at those of their vulgar equivalents, with corresponding obscurity of meaning. It is, of course, easy to cite decimal fractions which are in their lowest terms, but the fact stands that when we decide to limit ourselves to decimals we discard the process of reduction to lowest terms—a process which we always and instinctively resort with vulgar fractions because it is a simplifying process. Apart from and in addition to this the decimal form, as such, is less clear than its rival. Thus, comparing $\frac{1}{10,000} = 0.0001$, the former is the clearer in its meaning. Should any decimal enthusiast doubt this, let him add ciphers to both sides of the equation and he will soon be convinced. Few attempt to read long decimals intelligently, but resort to mechanical repetition of the figures, with no attempt to form a mental concept of value because of the obscurity of the form.

Comparing the two forms of expression, we find that the basic feature of the vulgar fraction system is facility for reduction to lowest terms, while the basic feature of the decimal system is reduction to a common denominator, since, by the actual or imagined annexation of ciphers, all decimal fractions may be treated as though their denominators were common—a feature that is of immediate value in addition and subtraction. The decimal enthusiast will at once add that it is of corresponding value in multiplication and division, but this, while true in some cases, is not in others. Thus, comparing $\frac{1}{8} \times \frac{1}{8} = \frac{1}{64}$ and $0.375 \times 0.375 = 0.140625$, the former is far simpler both in the operation and the result.

We find, then, that the vulgar fraction is simpler as a means of conveying mental concepts, while the decimal is simpler as a means of performing addition and subtraction. In some cases this simplicity in addition and subtraction is of large, and in others of little or no, importance. Its importance is at its maximum in a system of currency. In no other application of fractions is there such an immense amount of adding as in the keeping of accounts. Nowhere else is there anything to compare with the addition of ledger columns, and of invoices or bills of account. In a system of currency, however, the usefulness of the decimal system is limited to currency as written on the ledger or other page. In our own system the denominations of coins and paper money depart from the decimal ratio as far as is possible without the introduction of fractional values, as the annexed table of our denominations will show :—

Minor Coins.		Gold Coins.		Paper Money.	
Value.	Ratio.	Value.	Ratio.	Value.	Ratio.
Cent	5	Quarter eagle	2	1 dol. ..	2
Nickel (5 cents)	2	Half-eagle ..	2	2 dols. ..	2½
Dime (10 cents)	2½	Eagle (10 dols.)	2	5 dols. ..	2
Quarter (25 cents). ..	2	Double eagle		10 dols. ..	2
Half-dollar ..	2			20 dols. ..	2½
Dollar				50 dols. ..	2
				100 dols. ..	

In a system of currency which is heralded to the world as decimal, and which is the chief bulwark of our decimal enthusiasts, we find the ratio two in ten cases out of a possible fourteen! Thus does another decimal bubble collapse when pricked. Without going into details it is but proper to add that this set of denominations is far from being ideal or satisfactory, the decimal basis making this impossible. There is no better illustration of the limitations of decimals.

Turning now to fractional division of units of length as a means of obtaining a set of sizes to which mechanical work shall be done, we have before us two systems. The first is the historic binary system, in which the sizes are obtained by repeated halvings of the unit, and the second is the decimal system. Until the law stepped in to compel a change, mankind, throughout the world and since the beginning of time, adopted the binary system. To the well-informed on this subject the reason for this is clear. Its explanation would, however, occupy considerable space, and suffice it, therefore, to cite the fact. However, if decimal divisions are so superior, should not some people, somewhere, have discovered the fact spontaneously? Why should the law be necessary to compel the use of a superior thing? Does not universal selection for a common purpose prove superiority for the thing selected for that purpose?

As a matter of fact, decimal divisions are not used by those who are supposed to use them. The insert of your impression already cited (December 22, 1916) carries an engraving of a marine Diesel engine in which I find such expressions as 850, 1,285 and 750 (mm. in all cases). Why these expressions? Why write 1285 and not 1.285? Why this discard of decimals and resort to whole numbers which is universal in metric countries? Consult your own columns and you will find it so, even overall dimensions of locomotives, buildings and steamships being given in thousands of millimetres. Can any one claim that the little millimetre is an appropriate unit for the leading dimensions to which it is applied? If not—and it certainly is not—why is it used? Simply as a clumsy and awkward expedient to get rid of that gloriously simple and beautiful thing the decimal fraction—decimal division of suitable units being discarded and multiplication of a minute and obscure unit for great dimensions resorted to.

Again, to the well-informed, the reason for this is clear, but again suffice it here to cite the fact. The explanation is for you. Instead of devoting your columns to the glorification of decimal fractions, I suggest that you explain why those who are committed to their use do not, in fact, use them.

The metric system is proclaimed as the universal predominant system. As a matter of fact, in mechanical manufacture, the English system is the overwhelming predominating standard of the world. Consider our own railways—exceeding in mileage those of the remainder of the world—and add those of Great Britain, Canada, India, Australia, South Africa, and the remaining British Colonies. Consider British and American shipping, overseas and inland (while our oversea shipping is negligible, our inland shipping exceeds that of the remainder of the world). Consider the cotton mill industry, which, except in France, is, throughout the world, based on the English yard and pound. Without attempting an enumeration, consider all the vast mechanical industries in which the English-speaking peoples are first and the rest of the world scarcely in the reckoning, and then call the metric system universal! Rubbish!

F. A. HALSEY.

New York, January 18, 1917.

"SCREW-THREAD MEASUREMENT."

TO THE EDITOR OF ENGINEERING.

SIR,—In a letter printed on page 186 of your issue of the 23rd ult., the Cambridge Scientific Instrument Company deal with a type of male screw thread measuring machine constructed by them on behalf of the Small Screw Gauge Committee of the British Association. Reference is made to Mr. Arthur Brooker's paper on "Screw Thread Measurement" recently read before the Liverpool Engineering Society and reprinted in your issues of 2nd, 9th and 16th ult.

In Mr. Brooker's absence I should like to say, as one associated with him in this work, that from your correspondents' letter it may be supposed that the "microscope micrometer" described and illustrated in the paper is claimed by the author as his original invention. That this is not the case is shown by the following extract from the paper, referring to the various machines and apparatus dealt with :—

"The National Physical Laboratory gave sufficient information to enable such instruments to be made . . ."

Yours faithfully,

PHILIP BATES.

"The Hazels," Victoria Park, Liverpool,
March 3, 1917.

"CUTTING AND CHIPPING OF GLASS."

TO THE EDITOR OF ENGINEERING.

SIR,—In his letter appearing on page 111 of your issue of February 2, Lord Rayleigh asks if the process of chipping glass, by the contraction of a glue film on its surface, is in regular use. Some twelve or fifteen years ago Mr. Idris, of the Idris Mineral Water Company, invited the students in chemistry at the Royal College of Science to his works in the East End. I had the pleasure of attending, and during the inspection we were shown plate glass sheets (to be used for making advertising signs), the surfaces of which were chipped all over. Mr. Idris told us that the result was obtained by glueing a sheet of stout brown pape to the glass and allowing the paper to dry.

As the paper dried it contracted, and the adhesion of the glue to the surface was such as to enable the paper to pull pieces of glass out from the entire surface of the plate.

I cannot say whether or not the process is still in use, but doubtless the Idris Company will be able to supply this information.

About six years ago I inadvertently allowed a glue solution to dry up in a porcelain evaporating basin and, subsequently, on examining the basin and its contents, I found that the glue had pulled a piece of porcelain completely out from the bottom so as to leave a hole about 6 mm. in diameter.

JAMES F. RONCA.

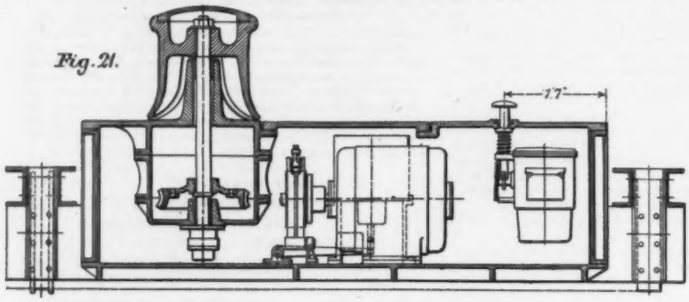
The Laboratory, 176, Elms-road, Clapham Common, S.W., March 6, 1917.

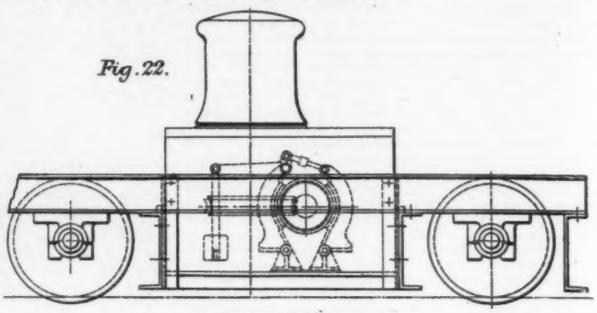
TRADING WITH THE ENEMY ACT.—The Controller of the Foreign Trade Department has sent us a copy of a new list of additions to the Statutory List of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade. Copies of this list can be obtained from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

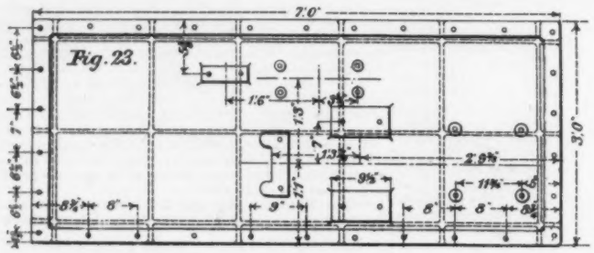
THE LATE DR. E. J. CONSTAM.—We regret to notice the sudden death by heart failure of Professor E. J. Constam, director of the Federal Fuel-Testing Station of the Technical High School at Zürich. Constam was born in New York in 1858, came as a child to Europe, and studied chemistry at Zürich under Victor Meyer. Continuing his studies at Strassburg under Kundt and Kohlrausch, he became chiefly interested in physical and thermochemistry. In 1881 V. Meyer appointed him his assistant at Zürich, and, after teaching for some time at Winterthur, he became professor of chemistry at Zürich in 1885. The Swiss Association of Steam Boiler Owners charged him, in 1899, with the testing of fuel, and in 1907 he was appointed director of the new Federal Fuel-Testing Station, which had been established on the petition of the Swiss railways. He did a great deal in simplifying fuel analyses and tests, and published many papers on coal, briquettes, boiler plant efficiency, oils for Diesel engines, &c. The fame of the institution spread particularly when the war broke out, but there was no space available for training students in the laboratories; that had to be left to the technical high school, with which Constam remained connected as professor.

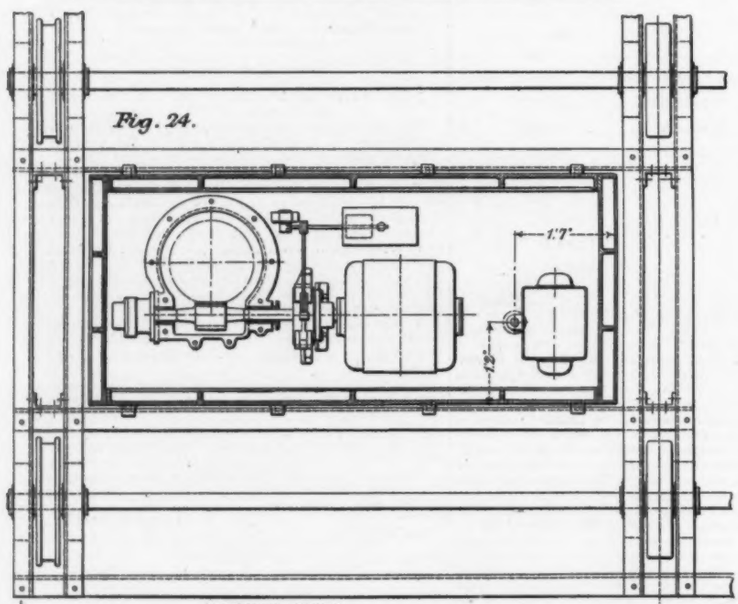
30-TON ELECTRIC TRAVERSER; MOOR-STREET STATION, G.W.R., BIRMINGHAM.

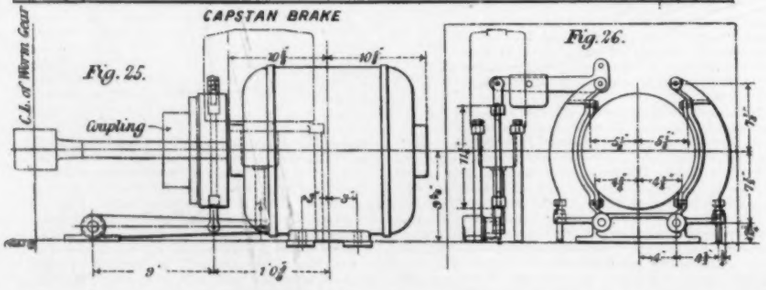
CONSTRUCTED BY MESSRS. S. H. HEYWOOD AND CO., LTD., ENGINEERS, REDDISH, STOCKPORT.

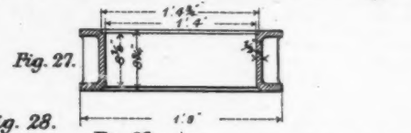


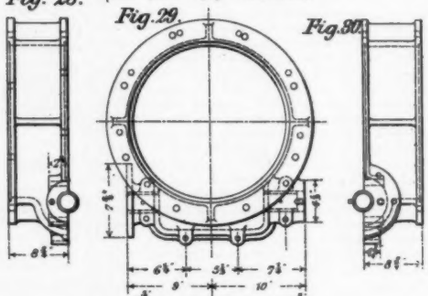


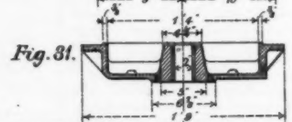


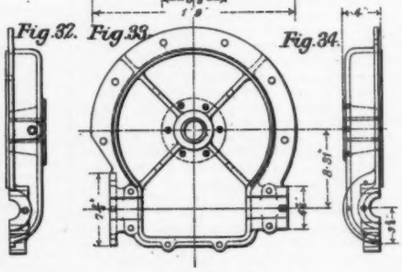


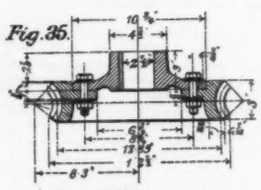


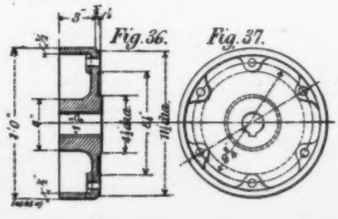








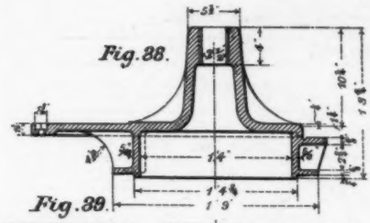


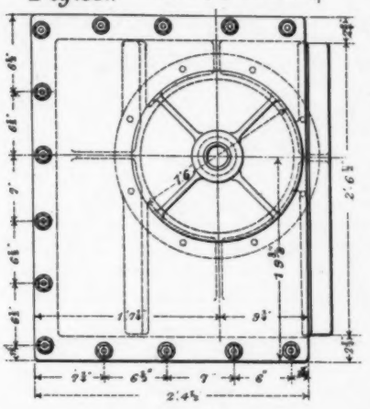


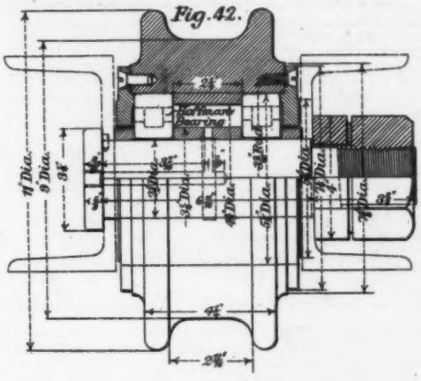
IN our recent account of the Great Western Railway goods station at Moor-street, Birmingham (see pages 50, 97 and 119 *ante*), we referred to the installation of two 30-ton traversers installed in connection with goods sheds A and B. Of the traverser belonging to shed B we gave a very fully illustrated description in our issue of March 10, 1916, page 228, and this week we give a corresponding account of the other traverser, working in connection with the shed A. As explained in the article referred to above the two traversers are of special interest because of the different methods of driving adopted—for special reasons—in the two cases. In the case of the traverser for shed B it was desirable not only that it should have a high speed of traverse, but also that it should be brought very accurately into position in relation to any of the sidings which it served. To facilitate this, Mr. Roger T. Smith, the electrical engineer of the Great Western Railway Company, adopted the plan of transmitting the torque of the three-phase induction motor (with which the traverser was fitted) to the driving wheels through Hele-Shaw variable-speed transmission gear. In the case of shed A only two sidings are served by the traverser, and prompt alignment of the traverser rails with these sidings was a matter of less importance, and it was therefore decided to drive the traverser by an induction motor of the cascade type, made by Messrs. Sandycroft, Limited, this motor being arranged to creep while exerting full-load torque. As will be seen from the engravings now published, the motor is connected to

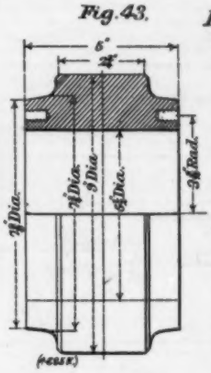
30-TON ELECTRIC TRAVERSER; MOOR-STREET STATION, G.W.R., BIRMINGHAM.

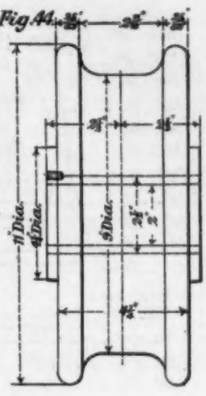
CONSTRUCTED BY MESSRS. S. H. HEYWOOD AND CO., LTD., ENGINEERS, REDDISH, STOCKPORT.

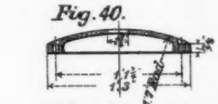


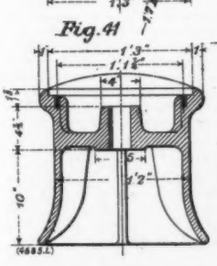


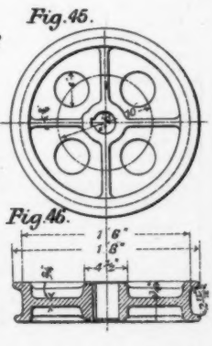












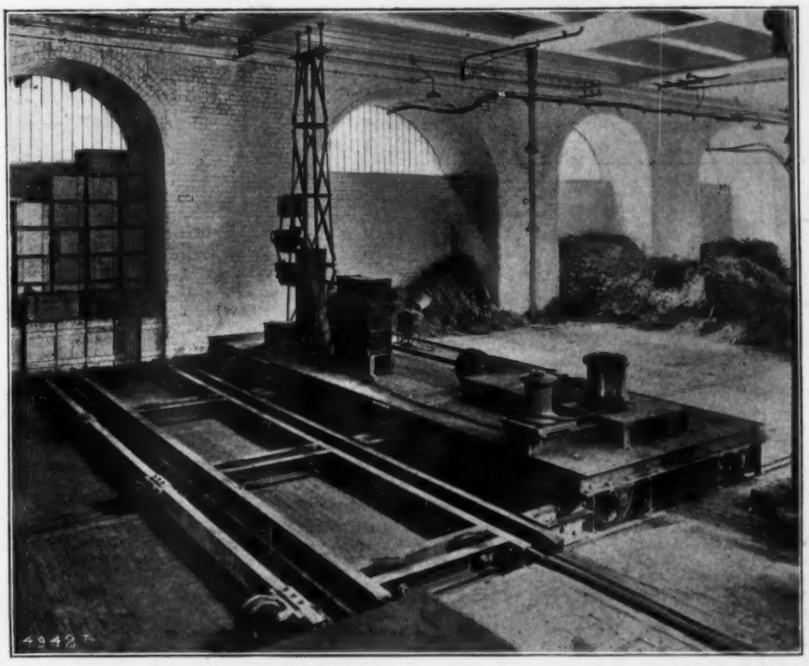


FIG. 53. GENERAL VIEW OF 30-TON ELECTRIC TRAVERSER.

the driving wheels of the traverser by a combination of toothed and chain gears. The traverser, we may add, was constructed by Messrs. S. H. Heywood and Co., Limited, of Reddish, stockport, to the designs and specification of Mr. Roger T. Smith, the electrical engineer to the Great Western Company.

Referring now to our engravings, Figs. 1 and 2, on Plate XVIII, are respectively a side elevation and plan of the traverser motor and a trailer attached to it, while Fig. 3 is a plan of the platform of the motor, Fig. 4 a side elevation of the motor framing, Fig. 5 a plan of the framing, and Figs. 6 and 7 an end elevation and transverse section. The trailer frame is illustrated in detail in Figs. 8 to 11, Figs. 8 and 9 being respectively elevations of the outer and inner longitudinals, Fig. 10 a plan of the framing, and Fig. 11 an end elevation. The details of the connection between the motor and trailer are shown in Figs. 12 and 13. The traverser in its run of 138 ft. has to cross a cart road at the entrance to the station from Park-street, and it was therefore desirable to keep the difference of height of the traverser rails and the rails of the sidings as small as possible. By careful designing this difference of height was made only 4½ in., the method of carrying the rails on the trailer being clearly shown in Figs. 1 and 11. Of the other views on Plate XVIII, Figs. 14 to 17 show the tower supporting the spring trolley collectors, while Figs. 18 to 20 show the methods of supporting the overhead wires.

The arrangement of the driving gear will be readily understood on reference to Figs. 1 and 2. The motor, which is a 30-h.p. cascade induction motor, constructed by Messrs. Sandycroft, Limited, of Chester, is mounted on the traverser floor, so as to be freely accessible, and a pinion on its shaft gears into a spur wheel mounted at one end of a countershaft about 8 ft. long, which also carries two chain wheels, the chains on which lead to corresponding chain wheels on the two axles of the traverser, as shown in the two views already referred to, these views also showing the positions of the controller, resistance frames and pedal brake. The weight of the traverser and trailer empty is 11 tons 18 cwt. 2 qr., and with a load of 30 tons it can travel the whole width of the shed at an average speed of 275 ft. per minute.

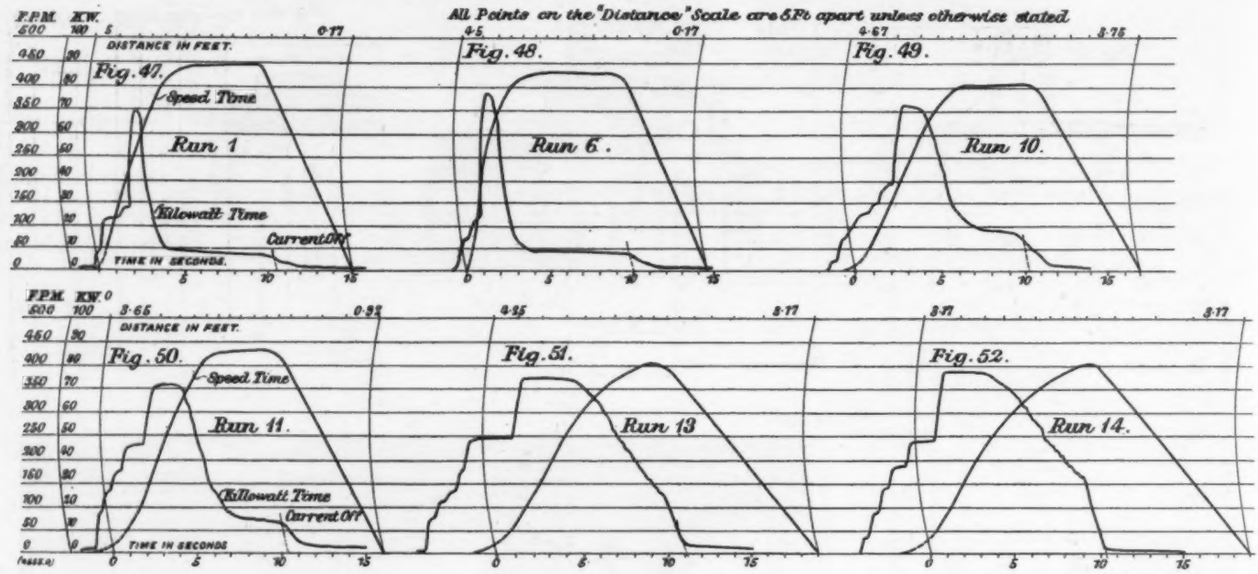
At the opposite end of the driving motor is mounted a hauling capstan-head using a slipping rope, and provided for hauling wagons on to, or off, the cage of the lift in connection with which the traverser is used. This capstan can exert a maximum pull of 2,000 lb., or a pull of 750 lb. at 300 r.p.m. It is driven by a Sandycroft squirrel-cage induction motor, with special high-resistance rotor windings, the object being to get great starting torque with small current expenditure. The general arrangement of the hauling capstan and its motor is shown by Figs. 21 to 24, on page 222, while Figs. 25 to 37, on the same page, and Figs. 38 to 41, above, show various details which will be readily identified. The vertical shaft carrying the capstan-head has fixed on near its lower end a worm wheel made up of a phosphor-bronze ring machined all over and bolted to an independent cast-iron centre (see Fig. 35). Into this worm wheel gears a worm cut solid on a short steel shaft which is supported in a pair of bearings and is connected to the shaft of the motor by a flexible coupling. The worm shaft also carries the brake drum, the arrangement of the brake being shown in Figs. 22, 24, 25 and 26. The blocks of the brake are lined with "Ferodo." The worm wheel and worm are enclosed in a cast-iron casing, the parts of which are shown in detail in Figs. 27 to 34, from which it will be seen that the bearings for the worm shaft are formed on this casing. The vertical shaft carrying the capstan head is provided at its lower end with a Hoffmann double thrust ball bearing The whole design of the hauling capstan is exceedingly neat.

The small vertical distance allowed between the tops of the rails on which the traverser runs and the tops of the rails on the trailer carrying the wagon which is being traversed necessitated the use of very small wheels on the trailer, these wheels being only 9 in. in diameter. To reduce friction, the axles of these wheels were fitted with roller bearings, as shown in the section, Fig. 42, annexed. The trailer is carried on 12 of these wheels, six of the wheels being without flanges, as shown in Fig. 43, above, and six having double flanges, as shown in Fig. 44. The arrangement of the wheels on the trailer will be seen from the plan Fig. 2, Plate XVIII. The bearings of the trailer axles are lubricated by Stauffer lubricators screwed into the ends of the axle pins, these pins being prevented from rotating by a suitable nipple.

The motor traverser is mounted on eight wheels, as shown in Fig. 2, Plate XVIII, four of these wheels

TEST OF 30-TON ELECTRIC TRAVERSER; MOOR-STREET STATION, BIRMINGHAM.

MR. ROGER T. SMITH, ELECTRICAL ENGINEER TO THE GREAT WESTERN RAILWAY.



No. of Record.	Particulars of Working and Net Load.	Direction East or West.	Distance Travelled in Feet.	Time of Journey in Seconds.	Average Speed in Feet per Minute.	Watt-Hours from Curve.	Tons Gross Load, Including Observers.
1	Traverser light with three observers	E to W	75.17	15	301	49.77	12.126
6	Traverser light with three observers	W to E	74.67	14.4	311	52.5	12.126
10	Traverser loaded with 15 tons and three observers	W to E	73.42	17	258	105.42	27.126
11	Traverser loaded with 15 tons and three observers	E to W	74.67	16	280	107.66	27.126
13	Traverser loaded with 30 tons and three observers	E to W	72.42	19	228	207.48	42.126
14	Traverser loaded with 30 tons and three observers	W to E	71.34	19	225	197.4	42.126

being flangeless and the other four having double flanges. Detail views of one of the wheels are given in Figs. 45 and 46, on page 223. In Fig. 53, page 223, we give a general view of the traverser, reproduced for convenience of reference from our previous article on the Moor-street station.

The tests of the traverser we have been describing were made on October 28 last, when, owing to a part of the run being occupied by military stores, only 75 ft. out of the 130 ft. travel were available. The weight of the traverser, light, was 11 tons 18 cwt. 2 qr., or 11.925 tons. A selection of the results is given in the annexed diagrams and table. The kilowatts of electric energy delivered to the traverser were recorded on diagrams taken with an Elliot three-phase (unbalanced) auto-recording wattmeter, with 100-ampere transformer range. The speed-time curve was plotted from relay pen marks on the wattmeter paper made by a hand-depressed key as the traverser passed over marks 5 ft. apart, except at the start and end of the diagram.

The controller has one notch for taking off the electric brake, followed by three creeping notches (2 to 4). The controller is always moved through these notches before coming on to the sequence of four working notches (5 to 8 inclusive). Notches 2 to 4 successively cut out resistances in series with the stator tappings, and notches 5 to 8 cut out more resistance in the stator tappings until, on the last notch, all resistance is cut out simultaneously from all tappings.

Twenty-two runs were made, and of these we reproduce the results observed in runs Nos. 1, 6, 10, 11, 13 and 14 (see table), in Figs. 47 to 52, annexed. In run No. 1 (Fig. 47) the traverser was light, except that it carried three observers. The speed, as shown by the large curve, attained nearly 450 ft. per minute, the average being 301 ft. The kilowatts, plotted on a time basis, are shown by the smaller curve, the maximum in the peak being 70. The watt-hours integrated from the diagram are 49.77, the point of cut-off of the current at 10½ seconds being marked with a dotted line. An expenditure of 49.77 watt-hours of electric energy in 10½ seconds is equal to an average input of 17 kw.

Fig. 48 gives similar particulars for another run under the same conditions; here the average speed is rather higher—311 ft. per minute—and the watt-hours 52.5. The runs represented by Figs. 49 and 50 were made with a load of 15 tons in addition to the three observers; the speed fell to 258 and 250 ft. per second, and the watt-hours rose to 105.42 and 107.66. The total weight was then 27.126 tons.

The load was then raised to 30 tons, and the total weight to 42.126 tons for the 13th and 14th runs (Figs. 51 and 52). The speed fell to 228 and 225 ft. per minute, and the watt-hours rose to 207.48 and 197.4, the current being cut off in each case after 10½ seconds. It will be seen that the acceleration was noticeably slower in these cases, and that the top speed was only maintained for a second or so. The effect of the movement of the controller from notch to notch is very clearly shown in these diagrams. It is to be noted that while the ordinates of the kilowatts curve are arcs of circles, the ordinates of the speed curves are vertical straight lines.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—War work continues to monopolise the entire energy of the steel makers in and around Glasgow, every available mill being constantly employed in the production of the material required by the Government, the demand for steel for shell bars being, at the moment, almost greater than ever, while, of course, as noted last week, that necessary for the standard boats ordered by the Shipping Controller makes a very considerable increase in the work which has to be undertaken. The position of the steel-making industry after the war is receiving much attention just now alike from the producers and those interested in the disposal of the finished material, but although various plans are discussed nothing of any great importance is yet definitely fixed, with the exception of the Scottish Association of Iron and Steel Merchants, a newly-organised institution formed for the purpose of safeguarding the interests of steel merchants after the war or as occasion demands. Export rates are still merely nominal, steel for ship plates running about 14*l.* 7*s.* 6*d.* per ton and up; boiler plates off and on about 15*l.* 10*s.*; and angles, 14*l.* 7*s.* 6*d.* and up.

Malleable Iron Trade.—The extraordinary activity which is the predominant feature of the iron and steel industry in the West of Scotland is very strongly shown in the malleable iron trade, makers being so well booked up with work that, with depleted staffs, they find the utmost difficulty in keeping pace with the demands made upon their resources. Both on home account and for export the steel departments are kept particularly busy, although iron in great quantity is also required.

Scotch Pig-Iron Trade.—During the past few days pig-iron of all grades seemed to be in even greater request, the demand for hematite being so specially active that the strain on the blast-furnaces is severely felt. This stronger feeling has caused a slight advance in export rates, but with practically the entire output going straight to the steel works little is available for overseas consumers. In the case of foundry grades, while the demand is good, the continued scarcity prevents any export being put through, as every possible ton is required at home. All over, prices are firm.

Scottish Association of Iron and Steel Merchants.—Quite a good beginning has been made by the members of this new association, which has just held its first annual general meeting in Glasgow under the presidency of Mr. W. H. Kidston, of Messrs. A. G. Kidston and Co. Mr. Kidston intimated that he and Mr. Robert Young had had a very satisfactory interview with the Board of Trade Iron and Steel Industries Committee, who had asked the association to send a deputation for the purpose of supplying reliable evidence regarding the prospects of the trade after the war. The evidence submitted by the two gentlemen mentioned had been well received by the Board of Trade Committee, and no doubt results will follow which will be highly beneficial to all concerned. With the view of establishing a good understanding with existing organisations the new association proposes to keep in touch with the Steel Makers' and Iron Makers' Associations for mutual benefit.

CORROSION OF PANAMA CANAL MACHINERY.—Corrosion has seriously affected certain parts of the lock machinery of the Panama Canal, says *The Iron Age*, and extensive renewals have been necessary, although the canal was finished less than three years ago. In this connection it is interesting to recall the destruction of the 500,000-dols. yacht Sea Call within a few months after its completion as the result of galvanic action between the Monel metal plates of its hull and its steel frames and fittings. Similar electrification between dissimilar metals in the valves controlling the lock water supply of the Canal has been an important factor in the difficulties at Panama. The corrosive action on the cylindrical valves has been severe. Considerable corrosion has taken place in the rising-stem valves. At both the Atlantic and Pacific locks considerable corrosion of roller trains has occurred, the rollers being made of tool steel. At the Atlantic locks a number of rollers, bolts and filler castings are missing.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—The situation does not grow any easier, and the inconveniences arising from the serious delays in transport are multiplying. The manufacturing section, owing to its preferential treatment, is being kept fairly well supplied, but even here works that have not railway accommodation find supplies arriving very infrequently and irregularly. The demand is heavy and increasing, but with pits held up by a want of empty wagons, there is a shortage of tonnage arriving. Larger sorts are fairly adequate, but steam nuts are again insufficient. Gas-coal pits are not providing inland gas works with all they require. Nor can they meet the big export demand for gas nuts. France and Italy are receiving the average tonnage of all qualities, but neutrals are getting the minimum of supplies. This week's return of wintry weather has added to the difficulty of the position, and considerably tightened the house coal department at a time when orders were getting down more to normal. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal, 17*s.* to 18*s.*; best large nuts, 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; smalls, 7*s.* 6*d.* to 8*s.* 6*d.* per ton at pit.

Iron and Steel.—We have excellent authority for stating that during the months of January and February the Sheffield works have produced more than during any three consecutive months of last year, and that the output still continues to expand. This is the outcome of the installation of modern engineering equipment, and of the new shops getting into full running order. In some sections notable progress has been made, and the demands of the authorities more than satisfied. To take that of ammunition alone, we are assured that this has made really amazing developments since last summer, and the works are making more steel blanks than the country has plant simultaneously to convert into shells. Steps are being taken to equalise the two processes, and then there will be shells and to spare. Despite the problems of substitution and man-power, steel works continue to round off a very large tonnage every week. The call for raw and semi-finished materials grows more and more insistent, and the metal market has a firm tone. There is not the slightest trouble in obtaining the full prices the Government scale allows. Lincolnshire and Derbyshire forge and foundry qualities are in strong demand. The production of Derbyshire pig-iron is to be greatly increased by the restarting of three more furnaces. Hematites are being consumed in enormous quantities, and the special brands are keenly sought. Steel billets are only obtainable for Government work, and no relief can be expected from America, for the quotations, with delivery at Liverpool, have actually risen to 16*l.* or 17*l.* per ton. Steel scrap is scarce and dear. There is a good market for shell discard steel. Agricultural engineers report progress. Though they have more orders on hand than they can hope to execute in time for the spring farm operations, yet they are producing abnormally large quantities, and are finding many difficulties removed by the Agricultural Branch of the Ministry of Munitions. Their supplies of steel are now much more easily obtained. The tool makers are very busy with orders for the Government and allied Powers. File and saw makers are also at full pressure. Cutlery and plate firms are still forging ahead, though the problem of material is still giving rise to concern. From overseas orders have arrived for tools, saws, plane irons, hardware, liner bars, bayonet steel, shovels, sheep shears, cutlery and steel.

SOME PROBLEMS OF RAILWAY CURVES.—On Wednesday, the 7th inst., Professor S. W. Perrott, B.A., M.A.I. (Dublin), M.Inst.C.E., read a paper having the above title before the Liverpool Engineering Society.

ROPE DRIVING.—Mr. R. E. Hart, M.A., M.Inst.M.E., of the firm of Thomas Hart, Blackburn, gave, on February 26, before the Bradford Engineering Society, a paper on the history and the development of rope driving in textile and other factories. He pointed out the great advantage of rope drives over other methods of power transmission from the points of view of reliability, flexibility, mechanical efficiency, resiliency under violent and sudden changes of load, and cheapness. The paper also contained practical information on the utilisation of ropes, splicing, &c.

THE LATE COLONEL FREDERICK WILLIAM TANNETT WALKER.—We regret to have to record the death, on the 6th inst., at Leeds, of Colonel F. W. Tarnett Walker. Colonel Tannett Walker was for many years in the Volunteer Service, and was at one time in command of the Leeds Rifles. In the early months of last year he was gazetted Temporary Lieutenant-Colonel in the Royal Engineers and went to France. He returned home about a month ago suffering from a nervous breakdown, which proved fatal. The deceased was the younger son of the late Mr. Benjamin Walker, one of the founders of the firm of Tannett, Walker and Co., Hunslet, Leeds. He had the V.D. medal, was for a number of years a member of council of the Leeds Chamber of Commerce, a member of the Leeds School Board and a Commissioner of the Peace for Leeds. He was a member, from February, 1891, of the Institution of Civil Engineers, and was 56 years of age.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—As was expected, with supply of Cleveland pig-iron rather plentiful, allocations for March to home users and to consumers in Scotland were on quite a large scale, but they were not sufficiently heavy fully to satisfy customers, with the result that further allocations are being applied for, and supplies are going forward fairly well. Scarcity of trucks, however, is still causing some irregularity in delivery. Some forward business continues to be arranged, but most of the transactions now recorded are for early delivery. Export trade is inconvenienced by the tonnage situation, which, however, is less unsatisfactory than it has been, and further improvement is looked for. Inquiries are not altogether confined to negotiations on behalf of our Allies, occasional attempts still being made to do business on account of neutral countries, and some sales to Scandinavia are being licensed, but the transactions are under special conditions. For home consumption No. 3 Cleveland pig, No. 4 foundry and No. 4 forge all stand at 87*s.* 6*d.*, and No. 1 is 91*s.* 6*d.*; for shipment to our Allies No. 3 is 97*s.* 6*d.*; No. 4 foundry, 96*s.* 6*d.*; No. 4 forge, 95*s.* 6*d.*; and No. 1, 102*s.* 6*d.*; and for export to neutrals No. 3 is 105*s.* and upward, and No. 1 110*s.* and upward.

Hematite Iron.—Fairly satisfactory accounts are given of the East Coast hematite branch of the staple industry. Home needs are receiving all possible attention, though the wagon shortage is interfering somewhat with deliveries. Export trade shows some improvement, and shipments to our Allies are being made as rapidly as circumstances will permit. Though there are considerable arrears of loadings to be made up, export licences are less difficult to secure than they have been, and dispatches to Italy are expected to be heavy over the next two months. The Italian Government are understood to be allocating supplies among consumers in that country. France continues to take very considerable supplies. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, 137*s.* 6*d.* for shipment to France and 142*s.* 6*d.* for export to Italy.

Coke.—Demand for coke for local consumption continues heavy, and the descriptions required are still realising the fixed maximum prices that have ruled for some time past, average blast-furnace kinds commanding 28*s.* at the ovens, and 30*s.* 6*d.* at the ovens being named for qualities low in phosphorus.

Manufactured Iron and Steel.—Little new is ascertainable concerning the finished iron and steel industries, but it is gratifying to learn that more steel is being released for private consumption, and that production of mercantile shipbuilding material, which is now heavy, is still steadily growing. Prices all round are very strong, but the only quotable change is an advance of 20*s.* in packing iron and steel. The following are among the principal market quotations to home consumers:—Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; double best bars, 14*l.* 10*s.*; treble best bars, 14*l.* 17*s.* 6*d.*; steel bars (no test), 14*l.* 10*s.*; iron ship-plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 19*l.* to 20*l.*; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 17*l.*; steel hoops, 17*l.* 10*s.*; heavy sections of steel rails, 10*l.* 17*s.* 6*d.*; packing iron and steel (parallel), 13*l.*; and packing iron and steel (tapered), 15*l.* 5*s.*

NOTES FROM THE SOUTH-WEST.

The Coal Trade.—Not the least important of the week's events in the Welsh coalfield is the step taken to endeavour to secure supplies of pitwood for the collieries. A serious situation has been created, but it is hoped that the efforts now made may result in a decided amelioration. What is proposed is that home-grown timber should be provided. The first difficulty had reference to the question of labour to ensure the cutting and transporting of timber from local woods so as to be more or less independent of overseas supplies. With the object of overcoming this a joint sub-committee representative of employers and workmen appointed by the Conciliation Board for the Welsh coal trade has been dealing with the matter, and after negotiations had been conducted an agreement has now been arrived at between the two parties concerned. On two points the Controller of Mines will have to be consulted before the scheme can be brought into operation, and the members of the joint sub-committee are endeavouring to secure an interview with Mr. Guy Calthrop, the Mines Controller, this week, to save further delay. In the meantime all the leading Welsh coal-owners have been putting their heads together with the view of co-operative effort. As a result what is now designated the Monmouthshire and South Wales Pitwood Association has been formed. Eighty-four colliery companies, representing an annual output of 40,000,000 tons of coal, have joined the new undertaking. This co-operative scheme provides for the deposit by each of the associated companies of 3*l.* per ton of the estimated quantity of pitwood which each concern will require. In this way the nucleus of the necessary funds has been raised. The situation, however, is still causing anxiety, and the additional expense will be very considerable. It is estimated that, unless the existing state of things materially alters, the provision of pitwood will entail an expenditure of 4*s.* or 5*s.* per ton on the output of coal. At the same time it is hoped that the new scheme will have a materially beneficial effect. On the coal market the chief topic is a report that the limitation freight schemes have been abandoned by the Shipping Controller at any rate so far as neutral tonnage is concerned. Though no official announcement has been made the prevailing opinion is that rates will be fixed from time to time for the various ports in accordance with the requirements of each port and the amount of tonnage available. That the scheme has been detrimentally affected by overlapping on the part of the various committees dealing with shipping is patent, and it is evident that steps are being taken to co-ordinate the work of these various bodies. The announcement of the members of the Advisory Committee to assist the Controller of Mines also gives rise to the hope that the difficulties which have handicapped the coal trade will receive serious consideration and that great efforts will be made for their removal. Meanwhile the market has remained quiet with supplies in excess of inquiries. Of late the authorities have had a little more tonnage at their disposal, but this has had practically no effect on prices as stocks are heavy. The position of good class small coals has slightly improved because of an increased Admiralty demand, and the best bunker descriptions have changed hands up to 16*s.*, whereas a week ago the top price was round 15*s.* 6*d.* Cargo sorts, however, remain plentiful and weak from 7*s.* 6*d.* to 12*s.* 6*d.* There has not been any appreciable change in the position of large coals. Second Admiraltys are round 24*s.* 6*d.*; Black Veins and Western Valleys, 24*s.*, and Eastern Valleys from 21*s.* for inferiors to 23*s.* 6*d.* for bests. The export demand for bituminous coals is slow, and prices are virtually nominal on the basis of 21*s.* 6*d.* for No. 2 Rhondda large, 18*s.* through and through, and 15*s.* for smalls. Pitwood remains practically unobtainable and readily commands 75*s.*

Another Shipping Deal.—Messrs. J. C. Gould and Co., Cardiff, managers of the Dulcia Steam Shipping Company, Limited, and the Haenton Steam Shipping Company, Limited, have purchased from Messrs. Griffiths, Lewis and Co., Cardiff, the management of the Griffiths-Lewis Steam Shipping Company, Limited, together with Mr. Griffiths and Mr. Lewis's shareholding interests. The deal, together with the other ships owned and building, will at an early date give Messrs. Gould and Co. the management of a fleet of 10 steamers with an aggregate deadweight capacity of about 70,000 tons.

New Newport Dry Dock.—The old entrance to the Alexandra Dock, Newport (Mon.), from the River Usk, has been taken over by the ship-repairing firm of Messrs. C. H. Bailey, of Cardiff, Barry and Newport, and is being converted into a dry dock approximately 420 ft. long by 65 ft. wide. The dock will be independent of the tides, as it will be entered from the wet dock. The dock, which, it is hoped, will be ready for use in the next few months, is adjacent to the present Commercial Dry Dock and will be equipped with the latest and most up-to-date time and labour-saving appliances. At the river end of the dock a solid dam is being constructed, and on this railway lines will be laid which will add to the traffic facilities of the port. Messrs. Bailey are the owners of the Tyne Engine and Ship Repairing Works, Newport and Barry, the Cardiff Junction Dry Dock and Engineering Company, and the Tubal Cain Foundry and Engineering Works, Cardiff.

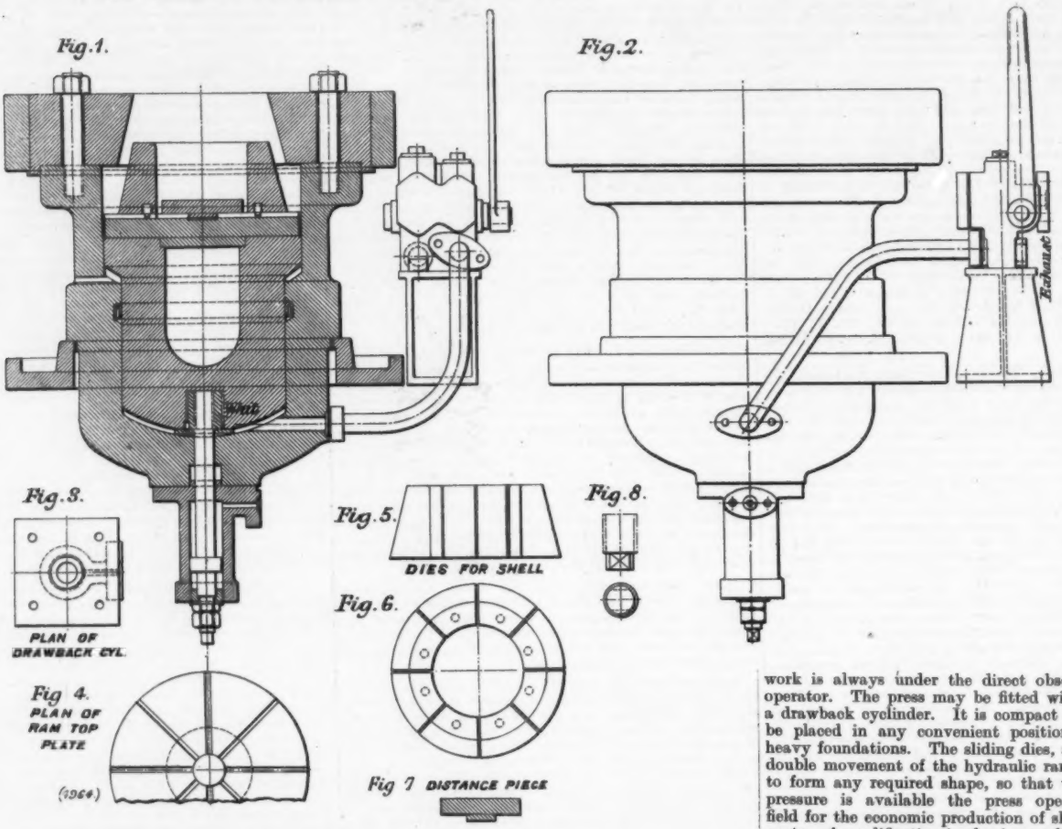
Miscellaneous.—The Penichyper Navigation Colliery Company, Limited, made a profit in 1916, after provision for excess profits duty, &c., of 49,227*l.*, against 62,636*l.* in 1915, and declared a dividend of 15 per cent., against 12½ per cent.—The Great Western Colliery Company, Limited, made a profit in 1916, after writing off 2,000*l.* for depreciation and providing for excess profits duty, of 181,240*l.*, against 137,007*l.* in 1915, and declared a dividend of 20 per cent., against 15 per cent. At a general meeting on March 15 a resolution will be proposed "That each of the existing 120,000 shares of 5*l.* each in the company's capital be divided into five shares of 1*l.* each."

THE LOCOMOTIVE STEAM SUPERHEATER.—The lack of energy in developing the superheater, says the *Railway Mechanical Engineer*, New York, even after the economy of superheated steam has been demonstrated, is an instance of indifference towards new devices manifested by American railways. The Clench superheater was patented in 1896, the Cole superheater in 1904 and the Schmidt superheater was developed in practically its present form in 1906. At the St. Louis tests in 1904 an engine equipped with a Pielock superheater showed a steam consumption of 16.6 lb. per indicated horse-power-hour, whilst the lowest steam consumption for an engine using saturated steam was 19.4 lb. In spite of this demonstration, there was only one railway on the American continent which took a prominent part in the development of the superheater, and the device was not generally applied in considerable numbers until 1912.

ASSOCIATION OF DRAUGHTSMEN.—The Association of Engineering and Shipbuilding Draughtsmen (London Branch) held their first general meeting on Saturday, February 10, at the Central Hall, Westminster, when officers and council, representative of the various firms in the district, were elected to carry on the work of the association within the London area. There were present about 150 members out of nearly 350 members comprising the London branch, and this membership is increasing week by week. Discussion on the future business of the association ensued, and Mr. L. Blair, the general secretary, of Glasgow, gave a short account of the work of the association during the past year. The total membership of this association is now over 5,000, enrolled from all branches of engineering and shipbuilding in Great Britain and Ireland. The address of the honorary secretary of the London branch is 38, Craster-road, Brixton-hill, S.W., to whom all inquiries from the London area should be addressed.

SHELL-BANDING PRESS.

CONSTRUCTED BY MESSRS. BABCOCK AND WILCOX, LIMITED, ENGINEERS, RENFREW.



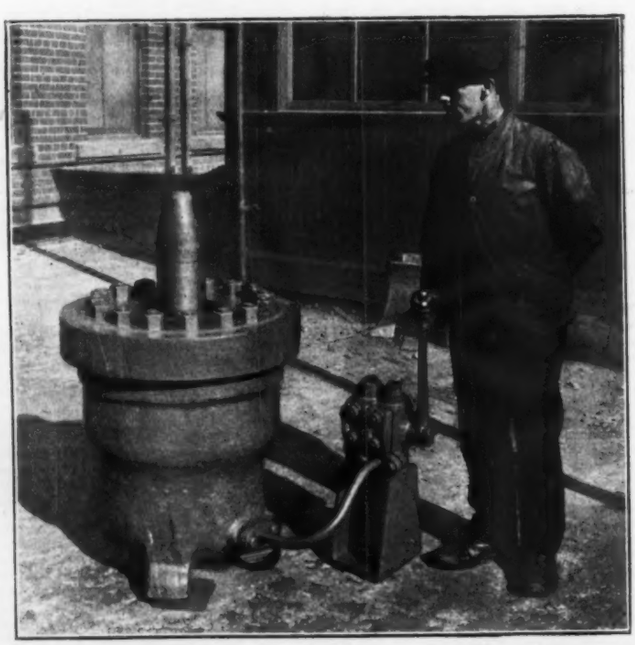


FIG. 9.

WE illustrate by sectional and other drawings, and by a perspective view, a press specially devised by Messrs. Babcock and Wilcox, Limited, of Oriel House, Farringdon-street, London, E.C., and constructed at their works at Renfrew, Scotland, for the speedy and efficient banding of shells, but convenient for application to a wide variety of operations on other articles. The construction and working of the press is so obvious from the drawings reproduced that little description is necessary, the strong feature being the simplicity of the action. It will be seen that there is only one control valve, placed close to the press, so that the work is always under the direct observation of the operator. The press may be fitted with and without a drawback cyclinder. It is compact in size and can be placed in any convenient position, requiring no heavy foundations. The sliding dies, actuated by the double movement of the hydraulic ram, can be made to form any required shape, so that where hydraulic pressure is available the press opens up a wide field for the economic production of shaped mild steel parts. A modification is also in use for heavier work, where the sliding dies are operated by a system of toggled joints instead of the solid cover shown on the illustrations.

THE SIMPLON TUNNEL.—H.M. Embassy in Rome reports, under date February 5, that work on the second Simplon Tunnel has been greatly impeded owing to war conditions. The work on the northern section was stopped in August, 1914, and was not recommenced until February, 1916, but work has been continued on the southern section with a reduced number of men. On July 31 a distance of 6,200 m. of the northern section and of 7,500 m. of the southern had been tunnelled. At the present rate of progress it is calculated that the former section will be completed on December 31 next, and the latter on August 31, 1918.

THE COST OF TRANSPORT BY RAIL.—Speaking before the National League of Commission Merchants of the United States, at Philadelphia, on January 11, on the occasion of the 25th annual convention of the league, Mr. G. D. Dixon, vice-president, in charge of the traffic of the Pennsylvania Railroad system, said he wondered how many Americans knew how low their freight rates really were and what a small part they formed of the cost of food. The American freight rates were the lowest in the world, but did people realise what that meant and the great advantages that it gave them? The railroads of America carried a ton of freight one mile for an average charge of $\frac{3}{4}$ cent. On the Pennsylvania Railroad this was done for an average of six mills, which included both high and low class commodities. The British railroads, built and operated under far lighter natural difficulties than the American, charged nearly four times as much for carrying freight as the Pennsylvania Railroad did, and three times as much as the average of the United States. Certainly it could not be denied that the railroads carried food cheaply. As a matter of fact the freight charges on food products were so small that it was generally conceded that retail prices, in the overwhelming majority of cases, would not be affected at all if the railroad transportation costs were wiped out altogether. In the case of milk, for instance, a thing which was very expensive and difficult for the railroads to handle, and for which they provided the very highest character of transportation service, it was hauled to Philadelphia for about $\frac{1}{4}$ cent per quart. It retailed at 10 to 12 cents, and even more for some brands. If the freight rates on milk were cut in half, it was not likely that the reduction of a $\frac{1}{4}$ cent per quart would be reflected by any change in the retail price.

30-TON ELECTRIC TRAVERSER AT THE MOOR-S

CONSTRUCTED BY MESSRS. S. H. HEYWOOD AN[illegible]CO., LI

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Fig.1.

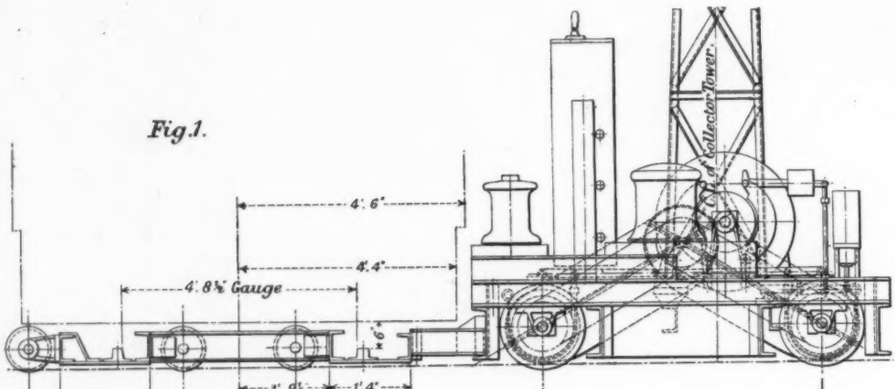


Fig.2.

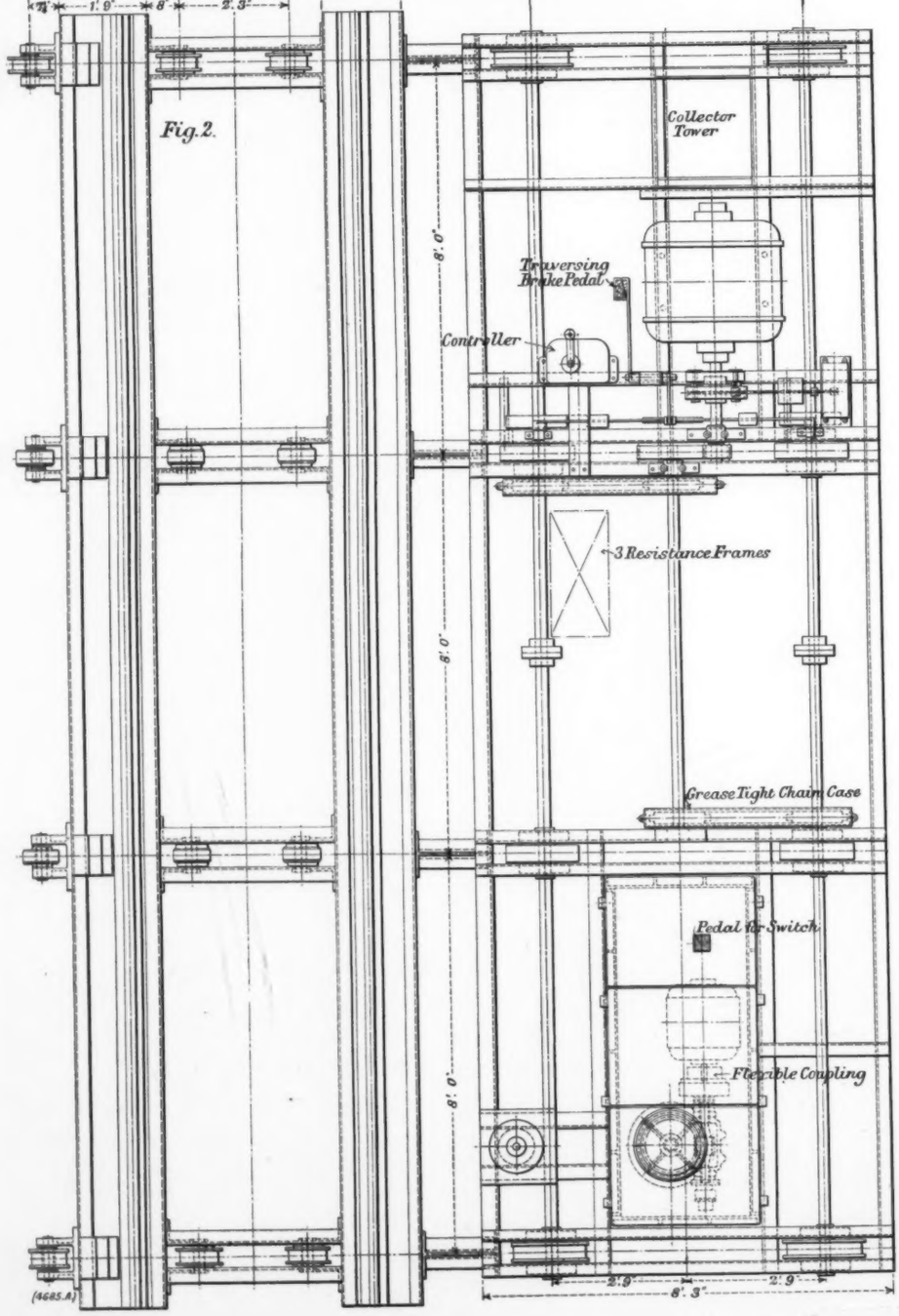


Fig.3. PLATFORM.

Fig.4

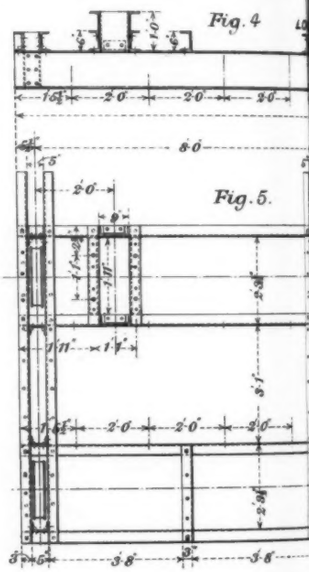


Fig.5.

Fig.6.

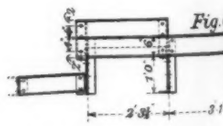


Fig.8. TRAILER FRAME.

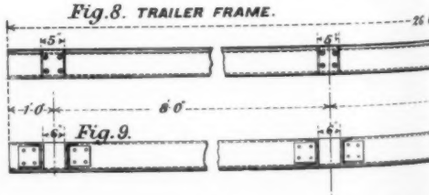
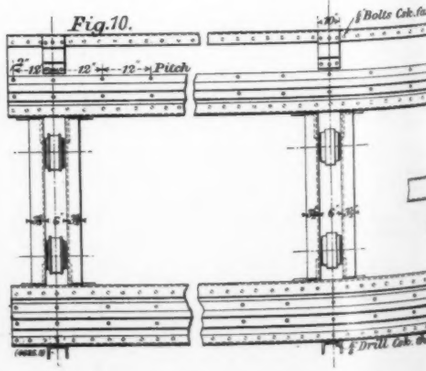


Fig.9.

Fig.10.



E MOOR-STREET STATION, G.W.R., BIRMINGHAM.

OOD AN CO, LIMITED, ENGINEERS, REDDISH, STOCKPORT.

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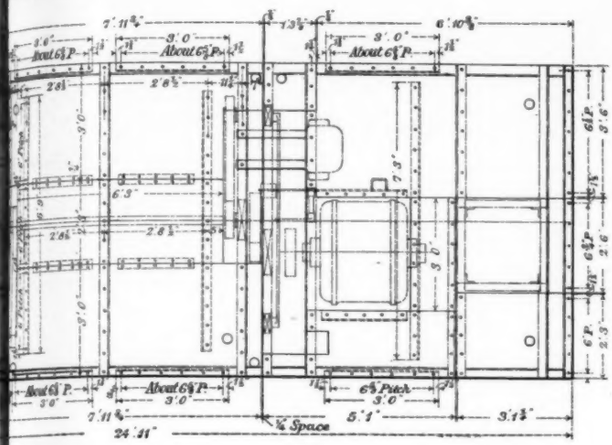
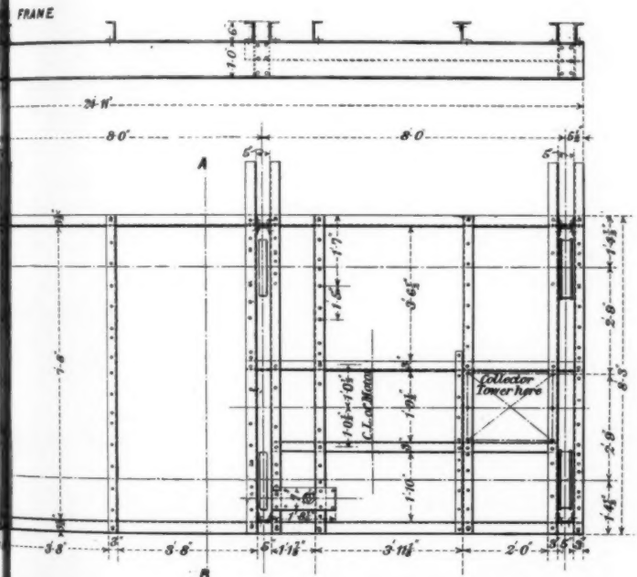
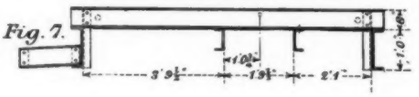
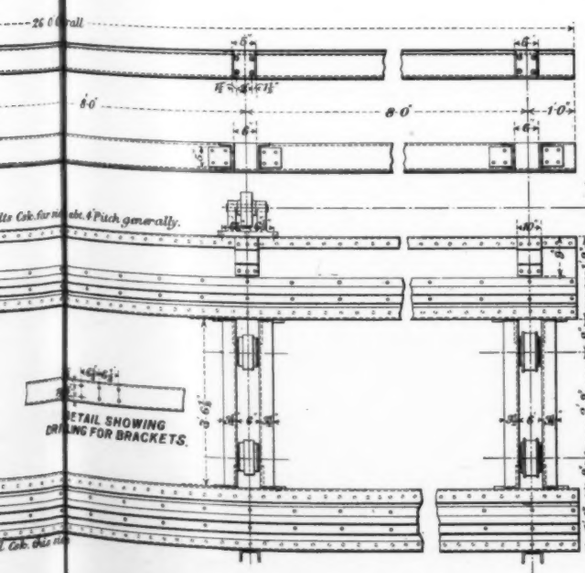


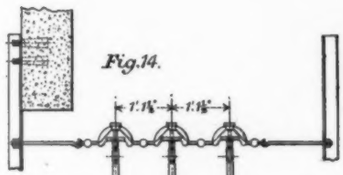


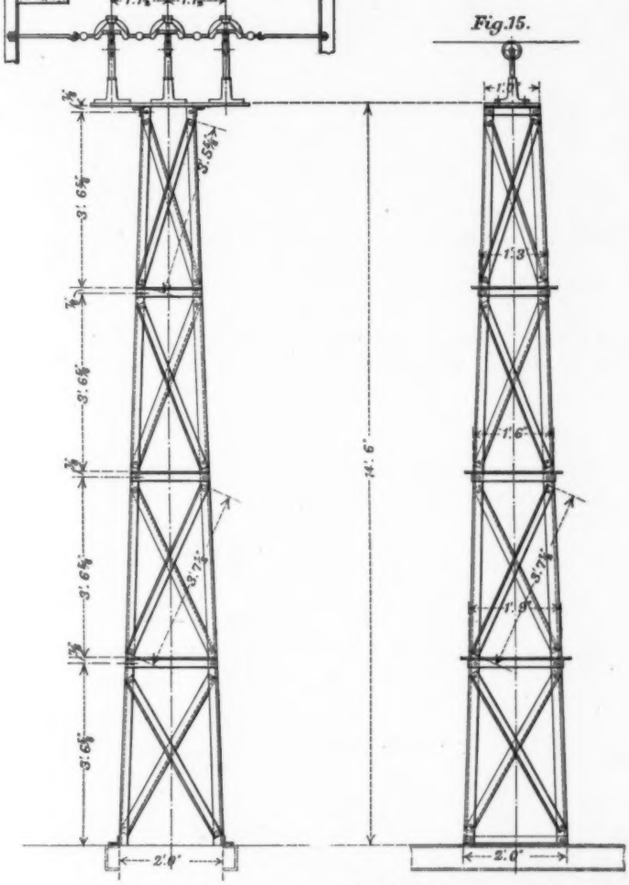
SECTIONAL ELEVATION THRO A-B.

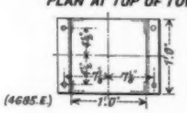
Fig.6 ND ELEVATION

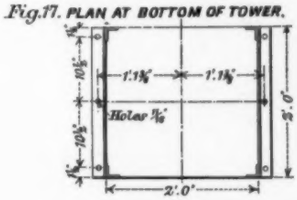


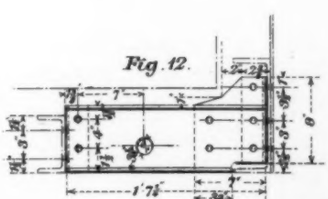


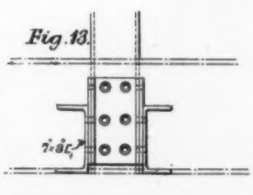




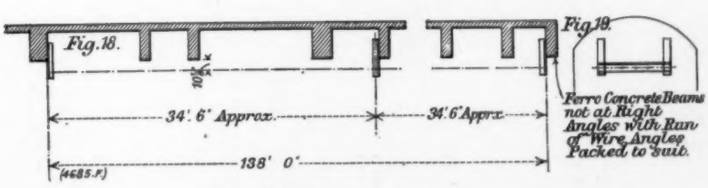


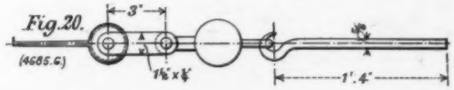






DETAIL OF CONNECTION BETWEEN LOCO. & TRAILER.





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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

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Thick ,, ...	£2	5	0
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Thin paper copies	£2	5	0
Thick ,, ...	£2	9	6

When foreign subscriptions are sent by Post-Office Orders, advice should be sent to the Publisher.
All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3683 and 8596 GERRARD.

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With a Two-Page Plate of a THIRTY-TON ELECTRIC TRAVERSER AT THE MOOR-STREET STATION, G.W.R., BIRMINGHAM.

NOTICES OF MEETINGS.

THE PHYSICAL SOCIETY OF LONDON.—Friday, March 9, at 5 p.m., at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W. Agenda:—(1) "To Measure the Pressure in a High Vacuum by Means of Logarithmic Decrement," by Mr. F. E. Shaw B.A., D.Sc. (2) "A Diffraction Colour Box," by Mr. A. W. Clayden, M.A. (a) "Demonstration of Interference Effect with a Thorpe Grating," by Mr. A. W. Clayden, M.A.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, March 9, at 8 p.m. Mr. C. Major on "X-Ray History" (electrically illustrated). Friday, March 16, at 8 p.m. Mr. C. P. Barber on "Munition Work Abroad."

THE INSTITUTION OF CIVIL ENGINEERS.—Monday, March 12, at 5.30 p.m. A lecture (under the Vernon-Harcourt Trust) by Mr. Edgar Crammond on "Foreign Trade and its Relation to the Investment of Capital Abroad." Members of the Institutions of Mechanical Engineers, Naval Architects, and Electrical Engineers, and of the Iron and Steel Institute are invited to attend the lecture.

THE ROYAL SOCIETY OF ARTS.—Monday, March 12, at 4.30 p.m. Aldred Lecture.—"Memorials and Monuments," by Mr. Lawrence Weaver, F.S.A. (Lecture II). Wednesday, March 14, at 4.30 p.m. "Fertilisers and their Supply in War Time," by Dr. J. Augustus Voelcker, Hon. M.A. (Camb.), Ph.D., F.I.C., F.C.S. Mr. Alfred Daniel Hall, M.A. (Oxon.), F.R.S., Member of the Development Commission and late Director of the Rothamsted Experimental Station, will preside.

THE SURVEYORS' INSTITUTION.—Monday, March 12, when the adjourned discussion on the paper on the "Defence of the Realm (Acquisition of Land) Act, 1916," read by Mr. Edwin Savill, Member of Council, at the last meeting on February 12, will be reopened by the Right Hon. the Lord Parmoor of Freith, P.C., K.C.V.O., K.C., Honorary Member. The chair will be taken at 5 p.m.

THE NOTTINGHAM SOCIETY OF ENGINEERS. — Wednesday, March 14, at 7.30 p.m., at the Welbeck Hotel, Nottingham, when Colonel G. M. Jackson, M.I. and S.Inst., the President, will occupy the chair, and Mr. W. Ralph Bates, M.I. and S.Inst., will take the vice-chair. A lecture will be delivered by Mr. David Rushworth, A.M.I.Mech.E., M.I. and S.Inst., on "The Fuel Economiser."

THE ASSOCIATION OF ENGINEERS-IN-CHARGE. — Wednesday, March 14, at 8 p.m., at St. Bride's Institute, Bride Lane, Fleet Street, E.C. A paper will be read by Mr. H. D. Searles-Wood, F.R.I.B.A., on "Plumbing as Applied to Public Buildings." Mr. Henry Adams, M.Inst.C.E., Past President, in the chair.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Wednesday, March 14, at 8 p.m., in the Hall of the Royal Society of Arts, John Street, Adelphi, W.C., when Mr. J. Lawrence Hodgson, B.Sc., A.M.Inst.C.E., will read two papers on "Airscrews."

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, March 16, at 5.30 p.m. A discourse will be delivered by Sir John Stirling Maxwell, D.L. The subject is "Scientific Forestry for the United Kingdom." Afternoon lectures next week at 3 p.m. Tuesday, March 13. Professor John W. Gregory, D.Sc., F.R.S., Professor of Geology, Glasgow, on "Geological War Problems" (Lecture I). Thursday, March 15. Professor Arthur Dendy, D.Sc., F.R.S., Professor of Zoology in the University of London, on "Sponges: a Study in Evolutionary Biology" (Lecture II). Saturday, March 17. Dr. Caleb W. Saleeby, M.D., F.R.S.E., "Imperial Eugenics—Saving the Future" (Lecture II).

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase will date from and include the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

ENGINEERING.

FRIDAY, MARCH 9, 1917.

THE RAILWAYS AND THE WAR.

WITH the consent of the Board of Trade the annual reports of the railway companies contain still fewer statistical results than last year. In 1913 the companies were for the first time required, much against their inclinations, to provide ton-mileage and other statistics of a similar character, by which some comparison could be made between the efficiency of operation in different cases. The reluctance of the companies to admit the innovation was in the main due to a realisation of the truth that there are quite a number of sanguine souls who are under the delusion that a study of statistics is in itself sufficient to enable them to give an authoritative opinion upon the working of any trade or industry. Those actually engaged in such undertakings know well that, at the best, statistics seldom make manifest more than half the truth. Sound conclusions can only be drawn from statistical facts when the student has himself a fairly extensive knowledge of the innumerable qualifying conditions that must be taken into consideration in ascertaining the true intent of the figures before him. The certainty that the data provided will be misunderstood by the ignorant is, however, no sufficient reason for their suppression, and we trust that publication will be renewed at the end of the war.

It is now nearly two and a half years since the control of the railways was assumed by the State, and it is really remarkable that there are still many people who are ignorant of the general character of the terms of the agreement then made. Quite recently a speaker in the House of Commons repeated the oft-scotched error that the Government had guaranteed the shareholders' dividends, and from questions asked at the recent railway meetings it is obvious that many shareholders are still under the delusion that they may benefit by the 50 per cent. increase in fares inaugurated last New Year's Day. As a matter of fact the bargain struck between the nation and the companies was far from favourable to the latter. The receipts from all but a few subsidiary sources were, it was settled, to be paid into the coffers of the State, and the companies were to receive back the same net earnings, less 2½ per cent., as they got in 1913. They thus received no return on any new capital which became productive after January 1, 1913, although the country got the benefit of it. All naval and military traffic, whether of passengers or goods, was carried free, and as men, machinery and material were commandeered for munitions making, the standard of maintenance had to be lowered on all lines. This bargain was, of course, too one-sided to be permanently maintained. Without Government assistance the companies could not on these terms have agreed to the demands of their men for the war bonuses granted to meet the increased cost of living. They did find it possible to pay one-fourth of the first bonus granted, but the further increases of pay have been met by the State, which also withdrew the deduction of 2½ per cent. from the net earnings of 1913 above mentioned. This it could probably well afford to do in view of the enormous increase in the receipts from goods and passenger traffic. Some companies, such as the London tubes, are still free from control, and these have had to provide from their own resources for the increased cost of labour and material; but, of course, they have themselves received the benefit of any increase in traffic.

The authorities have recognised that the companies are entitled to some return on the capital expended on new lines or other undertakings which have come into active operation since December 31, 1912. Amongst these may be noted the Dover Harbour works of the South Eastern and Chatham Companies, the widening between Finchley and Wembley on the Metropolitan Railway, and certain railways, warehouses and works of the Hull and Barnsley Company. All these new works have proved of much service to the country, and by the further agreement made four per cent. is allowed on the capital invested in them. This arrangement appears to be considered reasonably satisfactory by most of the companies concerned. Some, however, benefit little by the concession. The London, Brighton and South Coast line have, for example, large sums locked up in their electrical extensions, which it will be impossible to bring into service until after the war, and on this idle capital they will, even under the new agreement, receive no return.

Another concession made to the shareholders is an allowance for deferred maintenance, thus providing a fund which will be at the disposal of the companies for restoring their standard of maintainance to its pre-war level. Again, the nation has had the use of the railway companies' stores purchased at pre-war prices, which will certainly not be restored until a considerable time after the cessation of hostilities. It has accordingly been arranged in effect that the stores consumed shall be replaced at the expense of the Treasury at the end of the war. Most of the companies consider the allowance made for deferred maintenance as satisfactory, but the District Company expresses the fear that it may in its case prove inadequate. In general the sums received from the Treasury for this purpose have been invested in the new war loan, to which the railways have been very lavish subscribers. It was originally arranged that the Government were at liberty to cancel their agreement at a week's notice, which might have left the companies

in a very awkward plight; but the chairman of the Metropolitan Railway has expressed the opinion that the control will be continued until démobilisation is complete and normal conditions restored. Of course there will be a strong effort made by certain politicians to nationalise the railways permanently.

During the past year much has been done towards establishing a common user of goods wagons belonging to the different companies, and further measures are in hand. Certain classes of wagons are excepted from the new arrangement, and save in Scotland little has yet been done to solve the problem presented by wagons belonging to the private trader. In the nature of things there must, under the best possible management, be always a large mileage of returned empties. Coal wagons, for example, cannot well be used for anything but coal, even were return freights available, and must return empty to the collieries, and there are many other cases in which the "exports" from a district necessarily far exceed the "imports." A good deal had already been done before the war to reduce such idle mileage to a minimum, and as far back as 1913 practical steps had been taken by the principal Scottish companies towards the system of common user now established. No doubt this policy will be continued and extended after the war, but the benefits to be thus realised are often very grossly exaggerated.

It would be of great interest if the companies were in a position to supply data as to the total traffic over their lines during the past year. This, under present conditions, is impossible, for, as matters stand, the clearing house is out of commission, and thus, whilst figures are available as to traffic originating on the lines of any particular company, data as to traffic of "foreign" origin merely passing over their metals are unavailable. In addition there has been an enormous Government traffic carried free. Excluding this latter the traffic has attained record dimensions, and has been conducted successfully in spite of a loss of men to the Colours varying in the case of different companies from 16 per cent. up to 25 per cent. of the total staff. The London and North Western Company has provided 22,475 recruits, the Great Western Railway 20,000, and the Midland Company over 15,000. All the companies are giving assistance to the dependents of these men. On their return the fit men, it was announced at the Midland meeting, will be found work on the railways at the same rates of pay as if they had remained continuously in the railway service, whilst the partially disabled men will be found work they can do, and arrangements made as far as practicable to fit the machine to the man in place of requiring the latter to fit the machine. They will be paid at the rate of the grade in which they are put, without deduction for any pension they may receive from the State. Prisoners are also being looked after, the necessary funds being provided by contributions from both the companies and the men. In the case of the tube railways the men's contributions are stated to have averaged 3¾*d.* per head per week. Several of the chairmen at the recent meetings of shareholders spoke in warm terms of the way in which the men left in their service had faced the situation. Fortunately such inexcusable incidents as the strike at Paddington have been conspicuous by their relative rarity. The weather conditions last year made the work even more arduous than usual. The great blizzard of March 27 last did an unusual amount of damage, the Midland Railway being a special sufferer. Some 1,200 telegraph poles were brought down by the weight of the snow on the wires, helped by the strength of the wind. A piece of telegraph wire at Wellingborough, which in the normal state weighed 1½ oz. per foot, accumulated, it is said, such a load of frozen snow, that the total weight was no less than 16 oz. per foot. 9,000 miles of wire had to be replaced, and this work was hampered by dense fog. The telegraph constructional staff had, moreover, joined the Colours to the extent of 40 per cent., yet by the evening of the 28th traffic was again moving, and matters were nearly normal at the end of a fortnight, in spite of interruptions of night work due to four Zeppelin raids.

These raids, as is no doubt fully realised by the German war staff, have done extraordinarily little military damage, whatever their advertising value in the homes of the Huns. The Great Eastern Railway is pre-eminently that most exposed to attacks of this kind, yet the chairman was able to assure the recent meeting of shareholders that the damage suffered by their undertaking by the many raids last year was practically nothing.

Authorities agree that the recent increase in fares was inevitable, and is effective. The military authorities commandeered rails, equipment and personnel for some 4,000 miles of line, which have been laid behind the battle front in France and elsewhere. It was impossible to reduce the goods mileage, as this was heavier than ever and could not be diminished without serious injury to the supply of our fighting forces. The only alternative was, therefore, to reduce the passenger mileage, and many months ago appeals were made to the nation to travel only in case of necessity. Such appeals fell, as is usual, on deaf ears; but the raising of fares has been effective where the call to conscience failed. The Furness Company, for example, report that the number of passengers carried during the month of January last was some 50,000 less than in January, 1916, and the North Staffordshire Company reports a reduction of 20 per cent. Other companies have had similar experiences, which have shown them that still further reductions in the services will be practicable. Naturally, other remedies have been proposed. The most popular demand is that for the abolition of first-class carriages, though where the advantage would come in even the advocates of the policy are incapable of stating. It is not practicable, without almost rebuilding the carriages, to reduce the weight carried per seat provided to the third-class scale. The shortage of rolling-stock makes it necessary that all the carriages should be used, and it is better that the national exchequer should benefit by the higher first-class fares. Moreover, anyone who travels much nowadays will find the first-class coaches at least as well filled proportionately as are the seconds and thirds.

Complaint has been made of the new regulations requiring season ticket holders to show their tickets in the same way as ordinary passengers. This measure has been rendered unavoidable by the enormous increase of fraud, which is testified to by every company. With many cheating the railways had become a habit. Even young girls have not been ashamed to avow that they habitually travelled first with a third-class ticket, as they had merely to pay the difference if detected, and the large influx of inexperienced recruits to serve as ticket collectors much facilitated the other fraud of travelling with no ticket at all under the boldly uttered password of "season." According to the statement made from the chair at the Caledonian meeting it is not intended to retain permanently this daily inspection of season tickets.

The railway companies have been called upon also to hand over to the nation the best of their ships. But in spite of this the services are being maintained as far as practicable. The London, Brighton and South Coast Company, being unable any longer to obtain accommodation at Folkestone, have abandoned their passenger services, and merely maintain a goods service to London. The Great Eastern Company's services are particularly exposed to enemy attack, and the company has lost to the enemy two vessels, the Colchester and the Brussels. The commander of the latter was, it will be remembered, murdered in cold blood after capture, an atrocity for which the criminals concerned will no doubt receive their due when the terms of peace are being dictated. In the meantime the company has granted a life annuity to Captain Fryatt's widow equal to her murdered husband's pay, and has also made a large subscription to a memorial at Harwich. In spite of their losses and the requisitioning of other vessels by the authorities, the Great Eastern Company is still maintaining its continental services with five vessels, of which four have been chartered from other owners. Of the boats belonging to the South Eastern and Chatham Company, the Queen, notable as the first cross-channel boat to be fitted with turbines, has been lost, whilst its most modern boat, the Engadine, taken over by the Navy with officers and crew, was mentioned in Sir John Jellicoe's despatch for her services at the Jutland Battle. From the London and North Western Company the nation requisitioned the Hibernia, Anglia, Scotia, and Cambria. The former, renamed the Tara, was torpedoed, and the survivors of her crew were for a long time captives of the Arabs, being finally rescued by an armed motor car expedition led by the Duke of Westminster. Nearly all have re-entered the company's service. The Anglia was sunk by a mine.

Though progress has been slow with the electric traction schemes in hand at the outbreak of the war, a number of new electrified services have been brought into operation during the past year. The service between Manchester and Bury was opened last April and is said to be proving highly satisfactory. The North Eastern chairman gave a favourable report on the working of the Newport-Shildon Railway, which is the first heavy freight service to be electrically operated in this country. The London and South Western electrified system, of which the first section was opened on January 30, 1916, and the final section on November 20, is stated to be yielding results surpassing the most sanguine anticipations, the receipts for the whole year showing a net gain of 30,000*l.* The London and North Western has been less fortunate, being unable to obtain rolling-stock for its electrified lines to Watford. Arrangements have now been made, however, for running the services with stock obtained from the "Tubes," and in the meantime the lines have been operated by steam, thus relieving the traffic on the main line. The North London Company has only been able to run electrically a limited service between Kew, Richmond and Broad-street, which has, however, sufficed to prove the probability of a large recovery in the passenger traffic lost to competing systems during recent years. The ordinary services over this line, we may note, have had to be interrupted on several occasions during the year, no less than 3,164 special trains being run on Government account.

Capital expenditure has everywhere been reduced to a minimum, the record being achieved by the Midland Company, with a total of 27,000*l.* only. The South Eastern and Chatham Company is, we believe, alone in promoting a Bill this session, having as its object the strengthening of the Charing Cross Bridge. A similar measure was defeated last year by a surprise vote in the House of Commons, engineered by the architectural profession, by certain traffic competitors, and by a number of enthusiasts who look forward to an expenditure of many millions in beautifying the metropolis at the end of the war. These latter fail to note that their dream, if ever it be realised, cannot even begin to take a material form for many years to come, and that in the meantime the traffic must be carried. As matters stand, there are constant delays between Waterloo and Charing Cross owing to the precautions now necessary to avoid overloading the bridge. During the past fifteen years 398 bridges have been strengthened on this system so as to fit them for the weights imposed by modern railway stock, and the work now proposed is a necessary complement to what has already been accomplished. Petitions in favour of the Bill have been presented by all the principal public bodies in the area served by the railway, so that there is good reason to believe that when the measure is again brought before Parliament, common-sense will prevail. It is of some interest to note that when the South Eastern Railway was initiated, Parliament insisted that the company should provide a west-end terminus.

CELLULOSE INDUSTRY.

"WE are living in a chemistry of air and water, to which cellulose might be added as the third pre-eminent substance," said Mr. Charles Cross, B.Sc., F.I.C., last Friday evening, when introducing his Royal Institution discourse on "Cellulose and Chemical Industry, 1866 to 1916." Mr. Cross has devoted 40 years to the study of cellulose and has done so much in the development of the cellulose industry that his enthusiasm on this subject is quite natural. Everybody will, moreover, agree with his remark that to the people who were almost unconscious of air and took water as granted, cellulose,

which was the source of coal and timber and had become the most important constructive and destructive material, was little more than a name. Yet the cellulose industries ranked, he said, next to the iron industries, and the cellulose productions of this country were estimated at 500,000,000*l.* annually; the world's production of cellulose increased at the rate of 5 per cent. every year.

Mr. Cross began with the year 1866 because, he said, it marked the opening of a period of great progressive activity. In that year the use of esparto grass for paper-making had been started in this country. In the grass, as in other plants, the cellulose, itself a colloid, existed as a colloidal complex of cellulose and non-cellulose (lignone), and was further accompanied by mineral matter; the cellulose had thus to be isolated. The decaying leaf left a skeleton which, when purified with the aid of ammonia, &c., formed a beautiful object. The process could be accelerated by hydrolysis, treating the fibre with steam. Boiled with caustic soda esparto gave an excellent cellulose for the paper mill, and the production of esparto paper had rapidly risen until the introduction of the sulphite process had intervened. In that process, and in most other processes of isolating the cellulose, unfortunately, valuable organic matter, wax and oils (nearly 3 per cent.), &c., were wasted when the lye was evaporated and calcined. With the aid of a cyclone dust extractor Mr. Cross had recovered some of the wax contained in the esparto; it was only 0.1 per cent. of the grass, yet he produced 50 tons of this wax annually, the ton being worth 80*l.* In the bisulphite process for separating the cellulose from lignone, half of the original substance was wasted, and the many recovery attempts had so far achieved very little. The bisulphite treatment had been suggested and tried several times before it was really adopted in Norfolk by Ekman and George Fry.

The chemistry of cellulose, Mr. Cross continued, had been investigated by breaking-down processes and by synthetical processes; both the methods had led to important results. As regards the former, destructive distillation yielded acetic acid and other products, and the residual skeleton of cellulose still showed the texture of the original oak or beech wood used. Treated with sulphuric acid the cellulose turned into a gelatinous mass and finally into sugar (dextrose) and a black skeleton. When the reaction was interrupted in time, and the acid washed out, the cellulose could be recovered. When the fibre was impregnated with the salts of the rare earths thoria and ceria, for the manufacture of incandescent mantles, the burnt mantles still indicated the texture of the fibres, as was well known. That persistence of the structure was also characteristic of many of the synthetical reactions. Treated with nitric acid, cotton cellulose turned into a nitrate ester which was soluble in ether-alcohol (collodion) and, mixed with nitro-glycerin, gave cordite. It was true that the Germans nitrated wood pulp instead of cotton. Mixed with camphor and suitable solvents, gun-cotton yielded celluloid. When cellulose was nitrated, it increased by about 60 or 70 per cent. in mass, but the gun-cotton had all the appearance of cotton. Treated with acetic anhydride, cellulose likewise turned into an ester, again increasing about 60 per cent. in mass, and this acetate (or acetyl) cellulose resembled celluloid, being transparent and remarkably tough, but it was not inflammable, though not incombustible. Applied to aeroplane and balloon fabric as a dope, this product of the British Cellulose Company, of Derby, rendered the fabrics impervious to moisture and gases and imparted elasticity to them; the windows of the gas-masks were also made of this acetate.

So far as to acid treatment. That caustic soda (15 to 17 per cent.) made the cellulose swell was discovered by John Mercer in 1848, but mercerising was not taken up before 1880. The point was that the mercerised fibre shrunk when washed with water and assumed a lustre which was important for the dyer. The alkali treatment was for many processes, however, only a first stage. When wood pulp was treated with caustic soda, then dried, and further treated with carbon bisulphide, it became semi-transparent. Water transformed this substance into a yellow liquid, viscose, which spontaneously reverted to cellulose and formed masses of hydrated cellulose of the exact dimensions of the containing vessel. Even a solution of one part in 1,000 would coagulate, and the gelatinous cylinder obtained from more concentrated solutions gradually shrunk to a mass of extraordinary hardness. Technically, exhaustive washing of the coagulated mass was required to remove the sulphur compounds. The viscose could be mixed in substance with dyes and other materials, and was then called viscoid, a solid used like horn and ebonite for making umbrella handles, insulators, &c.

Viscose itself was very plastic. Spread by rollers it could be obtained in very thin, transparent sheets of great toughness in all colours; but it had to be borne in mind that the material shrunk very much in drying by loss of water, and to produce a sheet of 1 m. length one had to start from a sheet 1.5 m. long. The shrinking was utilised for providing bottles with hermetically-closing caps fitting over the stoppers and necks of the bottles. The viscose was for this purpose poured over the closed end of an inverted test tube of suitable size, which was then dipped into brine to make the viscose coagulate; the resulting glove of white viscose was pulled over the bottle, to which it clung tightly in shrinking. Squirted into brine the viscose yielded an artificial silk, of which many specimens in brilliant colours, including velvets or plushes, were displayed. The fibres were either single and rather coarse, or fine, up to 17 fibres being twisted to one thread. This silk-viscose could stand moisture and gave highly resistant yarns.

There were many other ways of converting cellulose into valuable products, Mr. Cross said, in concluding his discourse. He squirted a blue solution of copper-ammonia cellulose into caustic soda, in which it formed a thread; washed in acid, that thread lost its colour and turned into a white silky fibre. The subject was of the highest national importance; England had secured the lead, and should retain that lead.

THE CHEMICAL ENGINEER.

WHILE the war has done a real service in pressing the development of chemical industry and of chemical training on the attention of wide circles, there is danger that the call for chemists to man the munition factories and to the Front may result in the complete depletion of chemical students at colleges, and that the war conditions may encourage the development of unbalanced proposals for the training of the future leaders and workers in industry. In view of these considerations the Faraday Society arranged for a general discussion on "The Training and Work of the Chemical Engineer," which was held last Wednesday. The words we have just used were taken from the remarks with which Sir George Beilby opened the discussion. The subject has been much discussed of late, hardly, however, in the broad spirit of the discussion of last Tuesday, which was opened at 8 and adjourned—not closed—at 11 p.m.; that is to say, the Faraday Society, as usually, kept its audience as long as theatres do.

The introductory remarks by the President of the Faraday Society, Sir R. Hadfield, F.R.S., concerned the multifarious claims made upon the engineering chemist. Each major branch of industry demanded its special type of chemist, and ferrous and non-ferrous metallurgists, differing widely, *e.g.*, as to the ranges of their temperatures, required their own type of experience and training. With respect to State Organisation of Scientific Research, Sir Robert drew attention to the report which Mr. G. Lightfoot had presented to the Parliament of the Commonwealth of Australia and to the position of research in the United States, which had, in 1914, 69 agricultural colleges commanding an annual income of 7,000,000*l.*, in which 69,000 students were taught by 6,000 instructors; the Bureau of Standards could command 125,000*l.* annually. Sir Robert further wished to enlist support for the Ramsay Memorial Fund and the proposed establishment of a Ramsay Laboratory of Engineering Chemistry.

Chemical engineering, Sir George Beilby, F.R.S., said, in opening the discussion, had for its function the design and construction of the apparatus required for the carrying out of chemical processes on a manufacturing scale; apparatus is to be understood in the widest sense. To fulfil this function the chemical engineer must have at his command a great deal of knowledge and experience which was quite outside the range of the ordinary engineer. He had to deal with extreme temperatures and pressures; the reactions might be very slow or explosive, and the withdrawal or addition of heat often gave rise to problems of the greatest difficulty in the design of large-scale units—the failure of many processes was probably due to that reason; gases, liquids and solids had to be separated from complex mixtures and solutions; the materials of construction had to stand high mechanical stress and the attacks of highly corrosive gases and liquids, which were not rarely poisonous; electrochemistry introduced further new conditions. Sir George said he would entrust the general lay-out of the works and the power supply to the engineer, but the further design to the chemical engineer. The laboratory was the centre of all chemical activity. There failures were investigated, improvements worked out, and the materials and products were controlled. In the future the control also of the factory processes would pass more and more into the hands of the chemist; but that chemist would not be a man with a purely scientific training, which, with all its advantages, tended to produce a certain narrow individualism, but a man who had an engineering training. At the end of the third year (of the course of at least four years) Sir George would wish the heads of the college departments to advise students as to the directions in which they might specialise, and to pick out those students who showed mechanical aptitude. Those latter should be given special facilities in workshops and drawing offices; average students with no special bent would continue their advanced studies, while the chemical engineers, research chemists and specialists in other branches should devote one or two years to post-graduate study. Such a selection by the teachers of the special line of studies which a senior student was to adopt was afterwards advocated in stronger terms by other speakers. The question may occur: Will the student, who may not have made up his mind or may have other inclinations, and his parents submit? Dr. R. Robertson, of Woolwich Arsenal, questioned the advisability of what we may call compulsory selection. Dr. Beilby finally pointed out that the trained chemist seemed more apt to acquire the engineer's point of view than the engineer to look at chemical problems from the chemist's point of view.

Professor F. G. Donnan, F.R.S., of University College, London, speaking next, regretted that the general managers and process managers of chemical works were too often engineers without chemical training, whilst the so-called analyst was merely a tester who could calculate the results of an analysis, but nothing else. Without wishing to draw any sharp distinctions, Dr. Donnan would distinguish (1) research chemists, (2) engineer-chemists, and (3) chemical engineers. The research chemist was absolutely necessary; but he should co-operate intelligently with men of the two other classes, and for that reason should possess, next to the knowledge of physics and physical chemistry, some idea of engineering science, applied mechanics, engineering drawing, and thermochemistry and thermodynamics as concerning furnaces, steam engines, &c. Men of class 2, chemists mainly to control works, were required in much greater numbers than research chemists; their engineering training should be somewhat specialised for their proper sphere of work; they should be familiar with principles of design, power transmission, construction of flow sheets, &c. Men of class 3 should be thoroughly trained engineers, knowing as much chemistry as possible; chemical engineering was the greatest and most lucrative field of development for engineering science. To train these men schools or institutions of chemical engineering should be established. For Classes 1 and 2, the expert investigators of scientific problems, a five years' course was the minimum, the long vacations to be spent in works; suitable men would be found among the young university lecturers. Research was the culmination of the training in both their cases, and

the engineer-chemist should determine how a given process could best be carried out on a technical scale; to teach how to run a small experimental plant, rough buildings, sheds, well supplied with water, gas, power, draught, &c., would be required. The work of the engineer-chemist was essentially applied physical chemistry, and should be accurate and quantitative also as to costs. Dr. Donnan finally drew attention to the schedule of the Massachusetts Institute of Technology; there, we noticed, a selection of students was made at the end of the third year, but the subjects of the fifth year were largely elective.

The "Plea for the Forgotten Factor in Chemical Training," raised by Mr. W. R. Cooper, M.A., concerned the cost item, the technical efficiency, *i.e.*, the fullest utilisation of all the materials passing through the works, and the utility factor or commercial efficiency, the ratio of the quantity actually produced to the quantity which the factory might produce if continuously working, and thus the advantages of continuous and of discontinuous processes. The factor, the subsequent discussion showed, is not so much forgotten as Mr. Cooper assumes. He himself pointed out that the University of Birmingham had a Faculty of Commerce chiefly for the benefit of students to be engaged in the commercial conduct of manufacturing firms, Perhaps a grounding in business principles might be imparted within the four years' course which Mr. Cooper would not like to prolong; we should ourselves prefer not to burden the college course any further with matters which are better learnt in practice.

Mr. C. R. Darling, Lecturer in Physics at Finsbury Technical College, explained the type of instruction in physics which was given in his college. Physico-chemistry (electro-chemistry, osmotic pressure, &c.) was taught in the chemical department, following or parallel with instruction in applied physics. The utilitarian value of a subject like sound for a works chemist was that the ideas of waves and harmonic motion were best presented through that medium; 12 lectures were devoted to sound, but no time was available for laboratory work. The practical work in light consisted in making the student familiar with the instruments, microscopes, polarimeters, &c., which the chemist had to use later. The subject of expansion was explained with particular reference to fire-alarms, steam traps, properties of invar and silica. There were special lectures on fuel, thermal efficiency, refrigerators, and laboratory work with materials of high melting-points, heat insulators; the study of pyrometers, introduced 12 years ago by the late Dr. S. P. Thompson and Mr. Darling, seemed to fascinate the students almost to the detriment of other work. Numerical examples as to fuel cost and steam engine efficiency were worked out. Electricity was practically studied, of course. The students were always permitted to use the best instruments available; Mr. Darling does not believe in wasting time over makeshift apparatus; that question has its two sides, of course, and Mr. Hinchley, the next speaker, accentuated the self-teaching of the student and the advantages of initiative in the practical work.

Mr. J. W. Hinchley, chief of the section of chemical engineering in the Department of Chemical Technology of the Imperial College of Science, South Kensington, established in 1912 under the direction of Professor W. A. Bone, explained that the following principles had been laid down for the development of the department: the work should be post-graduate in character; no attempt should be made to set up manufacturing plant on a small scale and to teach more than the principles, with illustrations drawn from practice; mechanical drawing, workshop practice, factory organisation and economics should form an integral part of the course. The branches of chemical technology already provided for were (1) technology of fuel and cognate subjects, coal-tar, ammonia, explosives, and refractory materials; (2) chemical engineering; (3) electro-chemistry; and (4) organic chemistry (fats, oils, soap, sugar, gums, &c.) were to follow. Mr. R. Mond had presented a full-size experimental gas-producer plant to the college. The student of chemical engineering had to compile a reference book from which he could at once obtain information as to steam properties, rate of evaporation, loss of heat by radiation, properties of mixtures of ammonia and water vapour. He had to study experimentally units of plant filter presses, reaction towers, stills; to make drawings of plant tanks, bins; to prepare a design of a simple plant for a given output, draw up specifications and estimates, determine cost of production, devise a system of factory records for the control of the plant, &c. He was taught to use the most efficient methods of calculation instead of elaborate deductions, and was introduced to utility formulæ.

Mr. E. B. R. Prideaux, of University College, Nottingham, would distinguish between the research chemist and solver of technical problems, to be trained in universities with relatively small equipment, and the works chemist or manager, to be trained in technical colleges, somewhat on the lines suggested by Mr. F. H. Carr last year at the British Association meeting.*

A great many speakers followed. Sir Arthur Duckham, of the Ministry of Munitions, put in a plea, from his own experience, for the man trained in works and evening classes. Professor A. K. Huntington supported Mr. Cooper, and dwelt on the need of improving our secondary schooling; students came to college not knowing their arithmetic. Mr. A. P. M. Fleming, of the British Westinghouse Company, who had recently visited American technical institutions, speaking as an engineer, suggested that much of the instruction should be given in the works, where the student learned to understand men and acquired the works atmosphere—an important point. Research might also be conducted, as it was in America, partly in the college and in the works, where the investigators would receive a moderate salary; that was the practice of his firm. The human element should be more studied, and more should be done to attract the best elements.

Dr. W. Rosenhain insisted on the need of breadth of view. A man might fail in one branch and succeed in another because he had enjoyed a double training. The apparent friction between theory and practice was largely due to the complexity of industrial problems, which could not be solved by the study, in the laboratory, of some isolated property. Mr. W. McNab, F.I.C., said that the lack of chemical engineers in this country might be ascribed to lack of appreciation of their services; more exchange of opinions between manufacturers was very desirable.

Professor E. G. Coker welcomed Mr. Fleming's suggestion; so far teachers had great difficulty, unfortunately, in getting young men placed in works. If chemical students did not wish for engineering training, he would not force it upon them; specialising in the courses should in any case begin early; the chemist need not be bothered about valve gear, but should be taught all about flow of liquids. A young engineer sent to the chemical laboratory would make a good chemical engineer. While agreeing on the whole with Sir G. Beilby and Dr. Donnan—as everybody did, practically—Professor Coker did not see much difference between the engineer-chemist and the chemical engineer. Competition from America, to which several speakers referred, would certainly be strong, and they had wonderful colleges over there; but, Professor Coker thought, they tried to teach too many things and had too many subdivisions in the courses. The result, so far as Professor Coker could judge from his experience with Canadian students, was not always satisfactory, and the teacher was blamed, whilst the English student blamed himself when he felt bewildered. We are not sure that the English student might not rightly blame the professor, too, sometimes, and that is one of the reasons why we should hesitate to give the professor compulsory power as to laying down a course of studies for a student whom he may not understand. The difficulty of finding adequate and competent teachers, which will make itself more felt when the present aspirations are realised, was not touched upon.

Dr. E. F. Armstrong, managing director of Messrs. J. Crosfield and Sons, Warrington, spoke from the standpoint of the employer engaged in the manufacture of both organic and inorganic products on a large scale. As such he endorsed Sir G. Beilby's valuable statement on the training of chemists with all emphasis. He also agreed entirely with Sir G. Beilby's exposition of the difference in point of view of the chemist and engineer. The chemist having mechanical aptitude might become a plant chemist or engineer-chemist, able to make a rough design of a plant and to impress on the engineer, who had to make the finished design, exactly what he wanted. The chemist of the research type would have difficulty in passing from the laboratory to the commercial scale in his discoveries, and in conveying his requirements to an engineer. The difference was one of temperament, which engineering training would not entirely remove. The more engineering knowledge and aptitude a chemist had, the better, of course; but he was employed as a chemist, not as an engineer, and most firms would prefer to engage the latter separately. The chemical engineer of Mr. Hinchley, Dr. Armstrong was afraid, would lack the good properties of both the professions. Sir G. Beilby was right in classing the chemical engineer with the specialists in other branches of chemistry. Chemical industry did require specialists, men of four and even more years of post-graduate study, possessing exhaustive knowledge of their subject. Dr. Armstrong said he might refer to recent cases where works had been revolutionised by experts on the phase rule and on colloids. The chemical engineer would be invaluable in processes such as the synthetical manufacture of ammonia, which was in the main an engineering problem. But it was not desirable to replace all chemists by chemical engineers. Chemical industry wanted, above all, young chemists with a thorough knowledge of chemistry (organic and physical in particular), and that was quite enough to learn in four years. There had been too much specialisation. The hundred leading industrial chemists, Dr. Armstrong thought, would all deplore their insufficient knowledge of real chemistry, if questioned. The management, with all its daily duties, lost touch with the progress of the science. The British research chemist had no peers. Of the three biggest successes of the last decade, artificial silk was an English process; fat hardening, though discovered in Germany, had been worked out here; and only the synthetic ammonia had remained in Germany, because England had had plenty of ammonia for normal conditions. Dr. Donnan and others had pleaded for more co-operation from the manufacturer; Dr. Armstrong would go further, and suggest that academic councils should regularly seek the advice and criticism of manufacturers.

Mr. W. Gathorne Young, also a chemical manufacturer, underlined the last remark and Mr. Fleming's suggestions. If manufacturers were put on the advisory boards of the colleges, they would also give their money, and they would receive students in their works during vacation, as they could then make their selection of suitable engineer-chemists; his firm was ready to do this.

There were, among other speakers, Lieutenant H. C. Greenwood and Mr. F. G. Elliott, and further contributions had been sent by Messrs. G. S. Albright, Percy Spielmann, F. H. Caird and H. L. Heathcote. The amalgamation of the engineer-chemist and the chemical engineer does not appear profitable on the whole. It is feasible, we think, in special cases such as that of the chemical engineer for sugar works, who, on the Continent, is trained in special institutions. The general problem of the training of the chemical engineer and the engineer-chemist certainly remains very debatable; a large share should be left to the works. The value of co-operation of all parties interested is, fortunately, now understood.

* See ENGINEERING, October 20, 1916, page 375.

NOTES.

INTERNAL COMBUSTION ENGINES FOR TRACTORS.

IN a paper recently contributed to the Proceedings of the American Society of Mechanical Engineers, Messrs. A. A. Potter and W. A. Buck gave the conclusions reached as the result of an investigation into the fuel economy and thermal efficiency of the different types of internal combustion engines used for tractors. They stated that

whilst four-cylinder engines were better adapted to belt work, single-cylinder and two-cylinder engines were preferable when fuels other than gasoline were to be used. The piston speed for motors of this class should be less than in pleasure-car practice, and might be between 700 ft. and 900 ft. per minute. The valve-in-the-head type of cylinder had advantages over both the T and L types of cylinder head; whilst, owing to its mechanical simplicity, the jump spark provided by far the best means of ignition. The fuel consumption in such engines ranged, according to the authors, from about 1.3 lb. per brake horse-power-hour at one-quarter load down to 0.7 lb. per b.h.p. hour at full load, and was much the same whether the engine were driven by gasoline or kerosene. The thermal efficiencies attained ranged from 14.88 to 19.41 per cent. in the case of gasoline, the corresponding figures for kerosene being 13.7 to 15.97 per cent. In the matter of fuel cost, however, the advantage lay with kerosene. In the case of engines of less than 26 brake horse-power the cost per brake horse-power-hour was practically twice as much with gasoline as with the heavier fuel. With larger engines of 50 brake horse-power and upwards the discrepancy was less, but the cost with gasoline was still 1.62 times as much as with kerosene. The gain in fuel cost in using the heavier fuel was, however, to some extent discounted by the greater trouble of handling the kerosene engine and its shorter life.

Aluminium Carbide.

The formation of carbides is a very unwelcome factor in the reduction of many metals by carbon, and, on the other hand, the isolation of the pure carbides is often very difficult. In the case of aluminium, magnesium, tungsten, &c., the affinity of the metals for nitrogen further complicates the reactions. In their resumed studies of aluminium carbide (*Zeitschrift für Anorganische Chemie*, October 12, 1916, pages 312 to 335) Drs. O. Ruff and E. Jellinek heated aluminium and sugar carbon in a carbon crucible for 30 minutes to 2,000 deg. C. in a hydrogen atmosphere. Their commercial hydrogen was not free from nitrogen, and as the hot solid carbide readily absorbs nitrogen, their carbide contained in some cases considerable amounts of nitride, which is generally found in aluminium carbide. The resulting product had a deep orange colour. Treated with hydrochloric acid, the carbide Al_4C_3 should yield only methane; the carbide obtained generated some hydrogen as well, however, in one case as much as 19 per cent., and another carbide, lower in carbon, seemed also to be formed, especially below 2,000 deg. When the carbide crystallised from an excess of fused aluminium, the crystals were really Al_4C_3; there might be yet some other carbide present, though possibly the deficiency of carbon found by analysis might merely be due to the presence of metallic aluminium in the carbide Al_4C_3. When aluminium and carbon were mixed in the ratio Al_3 to C_2, a grey carbide, approximately of that composition, resulted, in which no metallic particles could be distinguished. At high temperatures the orange-coloured carbide proved distinctly volatile, but not without partial decomposition. This was studied by heating the carbide in a vacuum while slowly raising the pressure from 5 mm. to atmospheric pressure; there was volatilisation and decomposition, for the carbon percentage in the vapour increased, from 8 to about 15, as the temperature and pressure rose. At 2,270 deg. and atmospheric pressure the vapour contained from 13.3 to 14.1 per cent. of carbon; 14 per cent. would correspond to a vapour containing 55 per cent. of Al_4C_3, presuming the absence of other carbides. The crucible contained, at different temperatures, carbide only, or carbide and aluminium, or carbide, metal and graphite. In what form the carbide really existed in the vapour could not be ascertained. As to volatility, aluminium carbide seemed to resemble the manganese carbide most. The communication we notice is one of a series of papers on high temperature reactions and metals and carbon in which Professor Ruff and his collaborators are engaged.

Internal Combustion Engines.

Without touching upon historical points, Professor Dalby, F.R.S., in his second Royal Institution lecture, on "Internal Combustion Engines," delivered last Tuesday, explained the general problems with the aid of some happily-chosen similia of his own. He selected the gun as the simplest type of such an engine, the crusher gauge as simplest indicator, and a suction gas plant to illustrate the combustion phenomena. He then passed to his main subject, the determination of the actual gas charge and the measurements it involved. The weight, W, of the charge remained, he said, constant during a cycle, but as the mass of residual gas left was not known, the actual gas charge could only be indirectly determined, though the air and gas admitted could be measured. The determination was based upon the formula $P V = 100 T W$, in which 100 was a coefficient, applying with fair accuracy to gas engines in general. The pressure P could be measured, the volume V was known, and the method was to determine the T (absolute temperature) for one point of the diagram, then to deduce the corresponding W, and to use this value of W for the determination of the T at other points, with due corrections, of course. As the temperature of the gases fluctuated between 0 and 2,000 or 2,500 deg. C. within half a second, very sensitive instruments had to be used, and the otherwise suitable finest platinum wire, 0.001 in. in diameter, would melt. With the aid of the platinum resistance thermometer (bridge) of Callendar and of other devices, Professor Dalby had, however, been able to make temperature determinations. In order to explain why no current was flowing through the galvanometer of a Wheatstone bridge, Professor Dalby sketched out a tunnel (as in a London tube), dividing into two loops at junction 1, the loops reuniting at junction 2; near 2 were gates in both loops, and a cross passage connected the two loops between 1 and 2. When one of the gates was shut, the people approaching would return and pass through the cross passage. Similarly, when the resistances in the two bridge arms were not equal, a current would flow through the galvanometer. Connecting a Callendar bridge with an air cylinder, the lecturer showed that the expansion (and compression) of the air cooled (and heated) the wire, which in the gas engine thermometer had a length of $\frac{1}{8}$ in.; the time lag of this thermometer was only 0.01 second. He had first tried to put the thermometer in circuit by means of two contact brushes on the crankshaft; that had not answered, but his percussion contact, consisting of two springs on two cams, enabled him to take a measurement at any predetermined crank angle and to break the current immediately after closing it. Yet the thermometer wire would melt as stated. He had, therefore, designed a thermometer valve, a device by which the thermometer was pushed out of a closed recess, called a valve box, into the cylinder at the desired moment and returned to the closed valve box immediately afterwards. This device was automatically worked by a lever from a cam. The highest temperatures were deduced from the P V formula after determining temperatures of the charge up to 1,500 deg. C. In conjunction with Professor Callendar and Dr. Watson, and with the help of his perfected optical indicator, Professor Dalby had thus been able to take measurements with engines running at 1,800 r.p.m.; the governor had to be cut out in such work, to avoid changes in the conditions.

The German Submarine "Deutschland."

The American journal *Motorship* gives an illustrated description of the German commercial submarine Deutschland, built at the Krupp Germania Yard, Kiel. Her chief engineer is reported to have stated that her engines are of the four-cycle type, and that the Krupp bronze construction has been retained only in the two-cycle motors, the four-cycle being built of steel and cast-iron. The Deutschland, he adds, has two six-cylinder four-cycle Krupp engines, developing 600 brake horse-power each at 380 revolutions. The cylinders have a bore of 450 mm. (17.717 in.) and a 600 mm. (23.622 in.) stroke. Subsequently the chief engineer modified these dimensions to 400 mm. (15.748 in.) by 500 mm. (19.685 in.), and our contemporary adds on this point: "It does not, off-hand, seem reasonable that an error should be made in these figures, but *Motorship* does not wish to do an injustice, so both figures are given." The engines can run at from 200 to 400 r.p.m. "The four-cycle engine," said the chief engineer, "is rapidly taking the place of the two-cycle in Germany. The latter is used where high speed and power are required in compact form under special conditions, such as naval work, but for commercial work the four-cycle motor is in the ascendancy." Our American contemporary, in computing the performance of the engines of the Deutschland, seems to doubt both sets of figures given him by the chief engineer. The *Scientific American* also deals with the same ship, and states that she is 230 ft. in length, built on the usual system, having a circular hull proper, with what may be termed an enlarged false hull outside of this. The beam of the hull proper is 17 ft., the full beam of the ship being about 30 ft. She is driven by Diesel engines developing 1,200 h.p., the engines being six-cylinder, two on each shaft. The speed on the surface is 14 knots and submerged 7.5 knots. The time to submerge from surface conditions is two minutes. According to her captain the total distance run under the submerged condition on the last trip from Germany was 180 miles. American shipping men and naval architects estimate her cargo capacity at about 750 tons; the captain says this is 1,000 tons. The entire crew, with the officers, consists of 29 men. The Deutschland, like all the later German submarines, is always ready for submergence; the removal of the repeater compass on the conning-tower and the closing of the conning-tower hatch is all that is necessary. The German conning towers are large enough to hold four men. There is complete shut-off between the conning-tower and the rest of the ship when the ship is submerging. The speaking tube leading from the conning-tower to the man at the wheel has also a cut-off immediately behind the helmsman; hence should the conning-tower be shot away or punctured, two men would be lost, but the rest of the ship would be safe and could be steered from the second periscope. A small lifeboat is secured in the superstructure. The periscopes, two in number, are of great power and remarkable clarity, and are superior to American periscopes. The periscope in the conning-tower is hoisted and lowered electrically; the one in the engine room is hoisted by a chain drive operated by hand. The conning-tower is so arranged that air vents open and close automatically the moment the ship emerges or submerges; by this means the ship can proceed with the conning-tower only two-thirds above water, using her Diesel engines. The deck is absolutely flush and clear of gear of any kind. The two wireless masts are about 50 ft. high, built of wrought iron, tapering off telescopically at the top. When down, the masts are stowed in pockets on the false deck; they are raised or lowered by means of quadrants at their lower end, the quadrants being operated by motors. According to the captain the Deutschland was constructed in six months' time.

Personal.—Messrs. George Ellison, manufacturing electrical engineers, inform us that, the Government requiring their premises, Queen Anne's Chambers, they have, in conjunction with H.M. Office of Works, secured suitable London premises at 25, Victoria-street, Westminster, S.W. The head offices and works are now Wellhead-lane, Perry Barr, Birmingham.

Nottingham Electricity Supply.—In a recent address to the Nottingham Section of the Society of Chemical Industry, Professor H. E. Armstrong drew attention to the puerile policy pursued by the Corporation of Nottingham. Having a monopoly of electric supply they refused, he said, to furnish current for power purposes save at extravagant rates, and, as a consequence, many manufacturing firms had been compelled to instal their own power plants, involving, of course, unnecessary and expensive cartage of fuel. The speaker further stated that he had learnt that the heat lost in waste steam in the corporation power station would suffice to keep the whole town warm. Although in the centre of a colliery district, the fuel costs were much higher than at many smaller and less favourably situated stations, being 0.39*d.* per unit generated, although the total output was 12,860,000 units per annum. At the neighbouring town of Loughborough, for example, the coal costs for an output of 1,300,000 units per annum were only 0.28*d.* per unit. Taking all towns in which 10,000,000 or more units are generated per annum, Nottingham is, it appears from Professor Armstrong's paper, notable for the highest generating costs and the highest selling price, the two being respectively 1.04*d.* and 1.78*d.* per unit.

LITERATURE.

A Treatise on Electricity. By F. B. PIDDUCK, Fellow of Queen's College, Oxford. Cambridge: University Press. [Price 14*s.* net.]

THIS work is addressed to those who bring some previous knowledge to bear upon the subject and have had experience in the laboratory. Such a degree of mathematical proficiency is assumed on the part of the reader that complicated formulæ become intelligible expressions and are regarded as devices that shorten, without obscuring, demonstration. Some familiarity with the methods of using, and measuring with, physical apparatus is also implied. In works of this character too often a praiseworthy attempt is made to cover the whole ground and to adapt the treatise to the needs of both the tyro and the advanced student. Such attempts are rarely successful. The elementary descriptions of common phenomena usually weary one class, while the other rarely advances far enough to profit by the later chapters. Mr. Pidduck, perhaps as a warning, but certainly in fulfilment of the scheme he has arranged, leads off with the consideration of some important, but not simple, theorems, such as the Gauss, or Green, Transformation, Stoke's Theorem, and other propositions which will be needed in the sequel, and if the reader is not familiar with the equations of wave motion, and with the handling of Bessel functions, he is thus made early aware of the nature and extent of the preparatory work that is necessary before he can take full advantage of the theory elaborated. The author evidently has little sympathy with those who have not acquired the necessary mathematical knowledge, or he would more frequently have translated his formulæ into words, and emphasised the conclusions at which he has arrived.

Mr. Pidduck thinks it necessary to declare clearly his attitude towards modern hypotheses. He assumes that electricity implies an electric substance, as distinct from a state or condition of a body. By the process of electrification he understands the transferrence from the molecules of matter of something which is to be regarded as of atomic structure. The legality, or the convenience, of this hypothesis does not seem to call for either defence or emphasis: it affords a simple explanation of positive and negative electrification. If a body contains more than the normal number of electrons it is regarded as negatively electrified, if less, positively. A writer on optics would hardly feel it necessary to assert that he accepted the undulatory theory, but such a definition of his position would be fairly comparable to that adopted by the author. In each case some evidence may be wanting for complete demonstration, but the arguments in favour of acceptance are so overwhelming, that one would not expect any other hypothesis to be entertained. Just as in optics certain interference phenomena find their simplest explanation by the theory of wave motion, so in electricity the electron theory makes induction phenomena, especially those caused by the motion of conductors in magnetic fields, more easily intelligible. Again, Faraday's laws of electrolysis, with the modern interpretation of the ionic theory, point to the atomic constitution of electricity, and perhaps suggest experiments by which the electron theory may be firmly established. The strictest confirmation of the atomic structure of electricity comes, however, from the delicate experiments of Sir J. J. Thomson, Millikan, and others who have successfully determined the minute elementary charge in absolute measure. Millikan's methods and apparatus are described here very satisfactorily, and we may say of these, as of many experiments quoted by the author, where nicety of manipulation is needed, that the descriptions are distinguished by clearness and accuracy. They leave the impression that the author has repeated the work, and is not merely reproducing from original sources. Particular modifications needed for convenience in the laboratory are frequently mentioned.

The book divides itself into two practically equal portions: the first dealing with general principles, including magnetism, permanent and induced, so far as the subject explains or affects electrical phenomena; the second, with applied electricity, and the various problems that have been opened up by laboratory investigations on the nature of electrons, the ionisation of gases, the principles of radio-activity and allied problems. We are taken a little beyond conventional lines when introduced to the Zeeman effect on the behaviour of spectrum lines, and still more when the perplexities of the modern theory of "relativity" are brought under notice. The Zeeman effect is, of course, easily seen to be a legitimate subject for discussion, and we may congratulate both ourselves and the author on being invited to make an excursion beyond the ordinary limits of a text-book on electricity. But the claims of "relativity" are not so evident. We have been accustomed to trace its effects as arising from the restrictions unconsciously placed upon an arbitrary framework of reference, and consequently to limit its application to a particular kind of problem. We are forced to allow that the operating cause, once admitted, cannot be excluded from any branch of physical investigation, however remotely involved the principle may appear. Poisson's equation does not seem to be a likely avenue for attack, but the expression

$$\Delta V = -4\pi\rho$$

is not strictly applicable to electric phenomena in moving media, and the theory of Lorentz and Einstein is needed to complement it. This theory is sufficiently developed here to be followed clearly, and it may be said that just as in some previously unexplained gravitational problems "relativity" has removed some puzzling divergencies between observation and theory, so in physics the same principle has afforded a correct interpretation of the results of some experiments which have hitherto defied explanation.

It is, of course, pleasant to revel among the more recent marvels of scientific discovery and the triumphs of human intelligence and skill, but due appreciation of these refinements demands the patient and systematic study of the earlier portion of the work. Otherwise the author speaks a language that is not understood. Deliberately a consecutive thought is pursued through the preliminary subject of electrostatics, including the theory of dielectrics and cognate matters. The study of electric currents demands the use of such apparatus as the galvanometer, the ammeter, and the voltmeter, and the theory of those instruments is set out with some care. The moving coil galvanometer and some of the more delicate measuring instruments are described with great nicety, the method of reproducing the diagrams assisting the description very materially. We are inclined to regard the care bestowed on instrumental equipment and the adjustment of apparatus required for special experiments as a feature that has contributed in no small measure to the success, as it does to the interest, of the volume. Thermo-electricity is the subject of a short but important chapter giving the theory of the thermo-electric circuit. The discussion of induced magnetism and the induction of currents concludes the first part.

The second section embraces the application of electro-magnetic induction to power generators, transformers and alternating-current motors. The principles of electrolysis, which of recent years has found such wide practical application, also come under review. Electric oscillations raise the question of the theory of light, and the question of wave motion in that imponderable medium, the ether, which has been the fruitful source of so much controversy. But there is a practical side here, which receives attention, for the production and demonstration of electric oscillations have made possible the development of wireless telegraphy, whose extension, interrupted by the war, is destined to become a factor in civilisation. The last three chapters, on the conduction of electricity through gases, radio-activity, and the theory of electrons, contain the history of the science in the last 20 years. Within that limited time progress has been as swift as unexpected. It has witnessed the recognition of the electron as a discrete entity, with the formation of new views on the constitution of matter. The properties of the radio-active elements, the isolation of radium, the mystery of the emanations, the identification, or connection, of these with the atoms of radium, with electrons, or with X-rays respectively, constitute one of the romances of science, and their investigation belongs to the same period. The Röntgen rays held public attention for a while, but having been put to practical uses they have become part of the machinery of life. In the laboratory, however, they have a place in the engine of discovery, for by an ingenious application they have been made to reveal the structure of crystals.

Novelty explains much of the charm that attaches to these wonders, for if we review the steps by which electricity arrived at its present position, we shall find marvels quite as great, though familiarity has dulled our sense of appreciation. When Faraday demonstrated the induction of currents in metal masses moving in a magnetic field, and was thus led to the construction of a machine for the mechanical generation of electricity, he accomplished a feat of quite the same order as those that have aroused admiration nearer to our own time. The author's work, though not historical, yet, by exhibiting the theory in sustained order, corrects the perspective, and affords a surer estimate of the value of the successive steps by which electricity has acquired its importance in physical theory as in mechanical application.

BOOKS RECEIVED.

Power Transmission by Leather Belting. By ROBERT THURSTON KENT. New York: John Wiley and Sons, Inc.; London: Chapman & Hall, Limited. [Price 5*s.* 6*d.* net.]

Mining Mathematics, Senior Course. By S. N. FORREST, M.A., B.Sc. London: Edward Arnold. [Price 5*s.* net.]

Annual Report of the Department of City Transit of the City of Philadelphia, 1915. Philadelphia: Department of City Transit.

Canada Department of Mines. An Investigation of the Coals of Canada, with Reference to their Economic Qualities. Extra Volume, Supplementing Report No. 83. *Weathering of Coal.* By J. B. PORTER. Ottawa: Government Printing Bureau.

Report of the Minister of Agriculture, Province of Ontario, 1915. Toronto: A. T. Wilgress, King's Printer.

Proceedings of the Engineering Association of New South Wales. Vol. XXX. Edited by J. MCNAMARA. Sydney: The Association, Royal Society's House, 5, Elizabeth-street.

The Submarine Torpedo Boat: Its Characteristics and Modern Development. By ALLEN HOAR. New York: D. Van Nostrand Company; London: Crosby Lockwood and Son. [Price 9*s.* net.]

Can We Set the World in Order? The Needs for a Constructive World Culture. By C. R. ENOCK, C.E., F.R.G.S. London: Grant, Richards, Limited, St. Martin's-street, Leicester-square. [Price 3*s.* 6*d.* net.]

Elementary Physics for Engineers: An Elementary Text-Book for First-Year Students taking an Engineering Course in a Technical Institution. By J. PALEY YORKE. Cambridge: The University Press. [Price 4*s.* net.]

United States Bureau of Labour Statistics. Whole Number 195. *Unemployment in the United States.* Washington: Government Printing Office.

Forty-sixth Annual Report of the State Board of Health of Massachusetts. Boston: Wright and Potter Printing Company, State printers.

"The Ironmonger" Metal Market Report, 1917. London: "*The Ironmonger*," 42, Cannon-street, E.C. [Price 3*s.* 6*d.* net.]

Transactions of the Optical Society, London. Session 1915–16. Vol. XVI. London: The Optical Society, 39, Victoria-street, S.W. [Price 10*s.*]

The Motor Manual. Compiled by the Staff of "The Motor." Twentieth edition. London: Temple Press, Limited. [Price 1*s.* 9*d.* net.]

THE LATE MR. HORACE JAMES JORDAN HUMMEL.—We regret to have to report the death, which occurred at his residence, Carlton, Horley, Surrey, on Saturday, the 3rd inst., of Mr. H. J. J. Hummell. The deceased was 47 years of age. He became an associate member of the Institution of Civil Engineers in December, 1894.

AERONAUTICAL LECTURES.—The educational lectures on aeronautics now being delivered in St. Peter's Hall, Cricklewood-lane, N.W., each Thursday evening at 7.30 p.m., under the auspices of the Aeronautical Society of Great Britain, will be continued till May 3. The following are the subjects:—March 15, the Air Screw, by Mr. A. Fage; March 22, the Modern Aeroplane, by Captain F. Barnwell; March 29, Materials and Methods of Design and Construction of Aeroplanes, by Mr. R. O. Boswall; April 5, History and Development of Balloons and Airships, by Lieut.-Colonel Waterlow; April 12, Constructional Materials, by Lieut.-Colonel Waterlow; April 19, Stability and Control, by Mr. L. Bairstow; April 26, Aero-Engines, by Lieut. J. S. Irving; May 3, Meteorology and Navigation. Tickets can be obtained from Mr. Handley Page, 110, Cricklewood-lane, N.W., and from the secretary of the Aeronautical Society, 11, Adam-street, Adelphi, W.C.

THE LATE MR. H. H. SMITH-CARINGTON.

We regret to learn of the death, on the 3rd inst., at his Manchester residence, Grangethorpe, Rusholme, of Mr. Herbert Hanbury Smith-Carington, of Ashby Folville Manor, who is the last survivor of the colleagues of Sir Joseph Whitworth in the directorate of the now famous Openshaw works at Manchester, and who, since 1874, took a considerable part in the development of the establishment. His training was more "liberal" than technical, and he became associated with Sir Joseph Whitworth primarily on the commercial side, but his wise discrimination and ripe judgment had great influence in connection with many decisions affecting the general policy of the concern. Indeed, it may be said that he exercised a great influence upon Sir Joseph Whitworth, when, in 1880, it became necessary to find room for the inevitable expansion of the works, and when it was decided to purchase the then existing clayfields at Openshaw, in order that the works should be transferred from the old Chorlton-street site. This transfer began early in 1880, with the result that there has grown up not only the present immense establishment at Openshaw, but a large dependent community.

Born at Worcester in 1851, the elder son of the late Mr. Richard Smith-Carington, of Leicester, the subject of our memoir was educated privately and at King's College, London, and afterwards, for a short period, at Cambridge University. For four years he was at the Worcester Foundry of Messrs. Hardy and Padmore, and from thence proceeded to Whitworth's works, in 1874, to take up the position of assistant secretary to the company. Four years later he became secretary, and in 1887 he became a director. As we have said, his control was largely financial and commercial, the actual developments and manufacture being in the hands of his technical colleagues, but Mr. Smith-Carington exercised a beneficial influence in every respect in connection with the operations of the company. At the time of the amalgamation between Sir Joseph Whitworth and Co. and Sir W. G. Armstrong and Co., of Newcastle-on-Tyne, he became resident director of the works in Manchester, with a seat on the board of the amalgamated firms.

Mr. Smith-Carington took no part in the proceedings of institutions, the only one with which he was connected being the Institution of Naval Architects, of which he became an associate in 1899. He, however, was well known to engineers, particularly in the Manchester district; he was on the Management Committee of the Manchester Steam Users' Association and was a member of the Court of Governors and of the Council of the Manchester University. While deeply absorbed in all the affairs concerned with the company, he devoted much time to philanthropic and other work in the city of Manchester. Thus he had been chairman of the Manchester Southern Hospital for Women and Children and was vice-chairman of St. Mary's Hospital. His natural predilections inclined him to pursue the life of a country gentleman. As Lord of the Manor of Ashby Folville he took a large interest in the affairs of the county of Leicester, and, like his father before him, had been High Sheriff. He was also a deputy-lieutenant of the county, as well as a J.P. for the county and for the city of Manchester. He was greatly interested in agriculture and a successful horse breeder, and was a past-president of the Shire Horse Society. Indeed, his last visit to London was in connection with this organisation. He was for many years a director of the Royal Porcelain Works at Worcester, and an indication of another of his interests was his Fellowship of the Royal Historical Society. Soon after joining Messrs. Whitworth's firm he married Miss Stallard of Worcester, who, as well as three sons and a daughter, survives him. One of the sons, Mr. Neville Smith-Carington is on the London staff of Messrs. Armstrong, Whitworth and Co.

THE INSTITUTION OF CIVIL ENGINEERS: NEW HONORARY MEMBERS.—At the ordinary meeting of the Institution, held last Tuesday evening, the following were elected honorary members of the Institution:—Sir William Edmund Garstin, G.C.M.G.; Major-General Sir George Kenneth Scott-Moncrieff, K.C.B., C.I.E., R.E.

SYSTEMS OF SWISS ELECTRIC RAILWAYS.—By the end of 1916 the electric railways and tramways of Switzerland numbered 104, and their lengths aggregated 1,678 km. According to the tabulation given in the *Schweizerische Bauzeitung* of February 3, 1917, the length of the ten standard gauge railways is 172 km.; of these, 20 per cent. are on the continuous-current system, 22 per cent. on the three-phase, and 58 per cent. on the monophase system. On the 63 narrow-gauge and rack railways (one of which, 8.6 km., is standard gauge), of 1,020 km. length, continuous current predominates strongly, 87 per cent. of the lines being on this system, and only 4 and 9 per cent. on the three-phase and monophase systems. The 31 tramway lines, 1,486 km. in length, are, with one exception (monophase system) equipped for continuous current. On standard-gauge railways the preference for monophase service has long been pronounced.

INDUSTRIAL NOTES.

THE Minister of Munitions announces that he has made further Orders under the Munitions of War Acts, 1915 and 1916, under which 54 additional establishments have been declared controlled establishments. The total number of controlled establishments under the Munitions of War Acts, 1915 and 1916, is now 4,770.

Important awards were made on the 1st inst. by the Committee on Production (Sir George Askwith, Sir David Harrel, and Sir George Gibb) affecting the wages of men engaged in the engineering trades (including foundries) and in the shipbuilding trades. Representatives of a large number of trade unions connected with those trades have appeared before the committee within the past few days, the employers being represented by the Engineering Employers' Federation and the Shipbuilding Employers' Federation. The awards have been given under agreements effected between the employers' federations and the trade unions to refer the wages claims to the Committee on Production for decision. In the case of the engineering and foundry trades, agreements have recently been arrived at under which the former procedure of dealing separately with each of a large number of districts has been suspended and a new procedure adopted by which all the federated districts are dealt with in the one award.

The amount given under the present awards, which apply to all federated engineering and shipbuilding firms in Great Britain, is 5*s.* per week, payable as from April 1; and 2*s.* 6*d.* per week to boys and youths. The awards apply to time-workers, piece-workers, premium bonus workers, &c., and the amount awarded is stated to be intended to assist in meeting the increase in the cost of living. In the award for the engineering trade (including foundries) there is a further provision that in districts where the advances in time rates since the beginning of the war amount to less than 7*s.* per week a further advance is to be given sufficient to bring the amount up to 7*s.* The addition of the 5*s.* now awarded thus brings the war advances to time-workers in those trades up to not less than 12*s.* per week. The piece-workers in those trades, as in the shipbuilding trades, have already received an advance of 10 per cent. on piece rates as a result of findings of the Committee on Production; they are now to receive, in addition, the amount of 5*s.* given to time-workers.

It is announced that the Minister of Labour has appointed the following additional members to the committee which has recently been set up in concurrence with the Ministry of Munitions and the Director-General of National Service to advise and assist in connection with the substitution and reinforcement of labour:—Admiral Sir Francis Bridgeman, G.C.B., G.C.V.O., Alderman James P. Hinchcliffe, and Mr. Herbert Lockwood. The offices of the committee are at Quebec Chambers, Leeds.

The Prime Minister received last Tuesday, at 10, Downing-street, a deputation representative of the Executive Committee of the Labour Party, for the purpose of presenting the various resolutions dealing with labour problems after the war which were carried at the annual conference held in Manchester in January last. The Executive Committee were accompanied by the movers of the resolutions. The Right Hon. Arthur Henderson, M.P., and the Right Hon. John Hodge, M.P., were present with the Prime Minister.

Mr. George J. Wardle, M.P., as chairman of the Manchester conference and of the Parliamentary Labour Party, introduced the deputation. Mr. J. R. Clynes, M.P., presented and spoke upon resolutions dealing with demobilisation, the machinery for securing employment and the prevention of unemployment. Mr. W. H. Hutchinson on the restoration of trade union conditions and the Munitions Acts. Dr. Marion Phillips on the maintenance of the standard of life after the war, the legal minimum wage, including the extension of the Trade Boards Act and the position of women after the war. Mr. J. H. Thomas, M.P., on the nationalisation of railways and mines. Mr. J. Ramsay Macdonald, M.P., on agriculture, taxation and franchise.

The Prime Minister discussed various points in connection with the resolutions, and promised that the proposals put forward would be submitted to the new Reconstruction Committee.

An interesting case dealing with workmen's compensation was recently decided by the Court of Appeal. A workman met his death on March 10, 1916, whilst working in a colliery belonging to Messrs. Guest, Keen and Nettlefold. He had been in the company's employment for a number of years, but had followed other men on strike from July 14 to 22, 1915. The County Court Judge had decided that the week's strike constituted a breach in the man's continuity of employment, that he should be treated as having been in the company's employment since July 22, 1915, only, and his widow paid a compensation arrived at by multiplying the man's average weekly earnings since then by 156, or more than 300*l.*—the latter sum is the maximum payable under the Workmen's Compensation Act, 1906—instead of a compensation of 259*l.* The Court of Appeal reversed the decision of the County Court and awarded the latter sum as the compensation to be paid to the man's dependents.

A conference of 125 delegates of 42 Lancashire and Cheshire electrical undertakings was held last Friday, the 2nd inst., in the Town Hall, Manchester, with a view to consider a scheme for the interconnection of the electricity supply systems of the two counties. In the course of his remarks Mr. G. H. Roberts, M.P., Parliamentary Secretary to the Board of Trade, who presided over the conference, said he considered the matter of extreme importance, both to the nation as a whole and to the local authorities interested. In May last, he added, the Board of Trade sent a circular letter to the owners of electricity supply throughout the country, pointing out the probability of a shortage of coal and the necessity for economy. The Manchester conference was an outcome of that letter. He laid emphasis upon the part which electricity played in the development of British industries, and stated that if legislation were needed to further contemplated developments, the Board of Trade would be fully prepared to consider the subject favourably. Mr. S. L. Pearce, electrical engineer to the Manchester Corporation, said the adoption of the scheme of interconnection would result in a large annual saving in coal. The scheme was approved at the conference, and the plans and details, when worked out, are to be put before the Board of Trade.

The Board of Trade announces that the following appointments have been made in the Department of the Controller of Coal Mines:—

An Advisory Board representative of the coal-owners and miners in various districts has been attached to the Controller, and consists of the following gentlemen:—

For the coal-owners: Mr. Adam Nimmo, Mr. Arthur Pease, Mr. C. E. Rhodes, Sir T. Ratcliffe Ellis and Mr. Bramwell.

For the miners: Mr. Robert Smillie, Mr. W. Straker, Mr. Herbert Smith, Mr. Stephen Walsh, M.P., and Mr. Vernon Hartshorn.

The Controller will be assisted in financial administration by a Board of Financial Advisers, consisting of Mr. A. H. Gibson, F.C.A., president of the Institute of Chartered Accountants; Sir Woodburn Kirby, F.C.A.; and Mr. A. Lowes Dickinson, F.C.A. Sir Richard Redmayne, Chief Inspector of Mines, will assist the Controller in matters relating to the production of coal, and Mr. S. H. Hunt, of the London and North-Western Railway, in those relating to distribution. Mr. H. F. Carlile, of the Board of Trade, is acting as secretary to the department.

The annual general meeting of the Midland Iron and Steel Wages Board was held in Birmingham on Monday last, the 5th inst. The Board consists of 62 firms, of which 32 are in South Staffordshire and Shropshire, three in North Staffordshire, six in Lancashire, five in North Yorkshire, 13 in North and South Wales and in Cheshire, and three in Derbyshire. After moving the adoption of the report and statement of accounts for the year ended December 31, 1916, Mr. G. Macpherson, the chairman, urged the members present to endeavour to prevent all avoidable loss of work. In seventeen selected firms, he stated, there was a falling-off of about 28 per cent. in production as compared with the good peace year of 1912.

The Director-General of National Service has decided that National Service Volunteers may be supplied for work in the trades of primary importance enumerated further on. Employers who wish to receive the services of the Volunteers should obtain from the nearest Employment Exchange a form, N.S.V. 12, on which to make their application. The trades are the following: mining and quarrying; metals, machines, implements and conveyances; woodworking; pottery and glass trades; building and works of construction; textile and allied trades; chemical, oil, &c., trades; leather trades; transport; agriculture; food trades; miscellaneous manufactures; public utility services; and unspecified munition trades.

The Minister of Labour has appointed a committee of trade union officials to advise and assist the Employment Department of the Ministry upon matters affecting workmen in the building trades in connection with the working of Employment Exchanges.

THE LATE SIR BENJAMIN CHAPMAN BROWNE.

SIR BENJAMIN CHAPMAN BROWNE, whose death on the 1st inst., at Westacres, Newcastle-upon-Tyne, we deeply regret to have to record, represented a class of engineer who, while not directly and personally prosecuting engineering work, although trained as an engineer, largely influenced the progress of applied science and industry. He was a typical captain of industry and an almost unfailing judge of character, tactful in his control of those whom he placed in positions of responsibility, a capable administrator, anxious to ensure that manager, foreman and worker should find stimulus in reward and encouragement. His engineering training was wide almost to diffuseness, but when he concentrated his energies on marine construction he was, as a result of his wide experience, able to guide by advice without being absorbed in detail, so that the wide view he took was of advantage to those undertakings of which he was the head.

Born in 1839, at Yuley, in Gloucestershire, the son of Colonel Browne, late of the 9th Lancers, he came of a family having no connection whatever with engineering, so that he lacked in some measure the guidance useful in planning his scheme of training. He was educated at Westminster, and studied for one year, 1855–56, in the Applied Science Department of King's College, gaining entrance afterwards, as an apprentice, to the Elswick Works. Here he continued for four years in the shops, and for a further six months in the drawing office. In after-life he recognised his indebtedness to the training he received, because there was inculcated the extreme importance of accuracy, as the standard enforced by the late Lord Armstrong and those associated with him was then, owing to the character of the work done, of a much higher order than was the general practice in those days. On leaving Elswick the subject of our memoir branched into an entirely different department of engineering, and for a year and a half, 1861–62, he was engaged on the Falmouth Docks as an assistant engineer under Mr. Abernethy, and later in surveying, under Mr. Castle. His next appointment, between 1863–65, was on the Tyne Pier works, as an assistant engineer under Mr. Messent, while for four and a half years, from 1865–69, he was on Sir John Coode's staff as resident engineer on the Port Erin works and on the landing pier at Douglas.

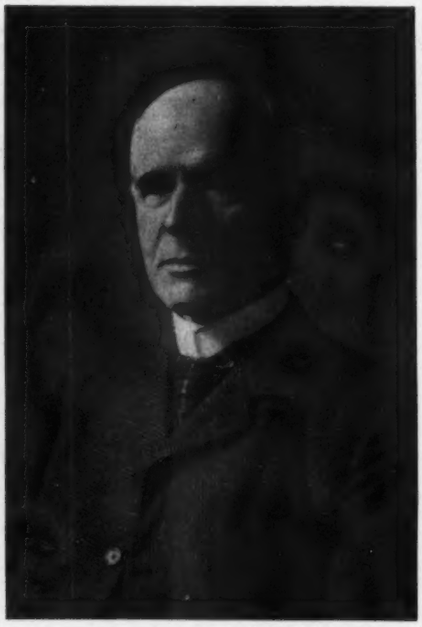
In May, 1870, when 31 years of age, he returned to mechanical engineering, and was one of several who purchased Hawthorn's Works on the Tyne, the property then of Mr. William Hawthorn, one of the two original founders of the business. From this time forward Mr. Browne became the captain of industry rather than the engineer. His training, because of its breadth and the exercise in resource necessary to overcome difficulties of great variety, proved of service, particularly as he recognised that the head of an establishment should leave the specialist manager of each department a free hand, offering guidance when sought for and giving at all times encouragement and support. The new copartnery was fortunate in the choice of the specialist at the head of the engineering department, the late Mr. F. C. Marshall, at that time manager of Palmer's engine department, who agreed to join the new proprietary of Hawthorn's Works. As is well known, Mr. Marshall exercised a great influence in the development of the high-pressure boiler and high-speed ship-propelling engine adopted by the Admiralty and other navies, so that success was early assured, and that success continued under Mr. F. T. Marshall (who succeeded his father) until his early death in 1905, and under later directors of the department. The Hawthorns were also known as one of the oldest locomotive-building firms in the country, their Forth Bank Works being founded for this work in 1817. But when the railway companies, and particularly the North-Eastern Company, decided to construct their own engines, Hawthorn's Works, like those of Messrs. Stephenson, experienced a severe check in their prosperity, and those responsible, including the subject of this memoir, had to exercise the greatest enterprise to secure a foreign *clientèle* and further to develop work in the provision of a factory for mining locomotives and travelling cranes. Later, the locomotive works absorbed the business of Black, Hawthorn and Co., and part of the old locomotive works of Messrs. Stephenson.

Mr. Browne (as he then was) made a further development in the business by arranging the amalgamation with Smith's St. Peters shipbuilding yard, and the shipbuilding yard at Hebburn founded by the late Mr. Andrew Leslie in 1831. This latter combination was arranged in 1885, and developments have been made from time to time in the shipbuilding and marine engineering departments. The firm, under Sir Benjamin's direction, has since become one of the most prominent of the builders of torpedo-boat destroyers and of turbine machinery for all types of warships. In 1887 he became a trustee for the Atkinson property, which included large collieries, building land, and other matters, and in this way was brought into direct contact with the colliery industry. He was connected, too, with the formation of the Newcastle and District Electric Lighting Company and the Cambridge Electric Lighting Company, in connection with the Hon. Sir Charles A. Parsons, both companies taking a prominent part in the exploitation of the turbine for the driving of electric generators.

Sir Benjamin, with his keen interest in all educational problems, recognised that in the conduct of all works advantage must accrue by systematising the training of apprentices, and he was able to induce his colleagues to give absolutely free technical training at any classes which the apprentices could be induced to attend. Prizes and other benefits were given for regular attendance and examination passes. The most efficient boys were passed into the drawing office, and were further encouraged to pursue scientific knowledge of their work. He was much interested, too, in various educational institutions, and took an active part in the founding of what is now the Armstrong College at Newcastle. The Durham University, for his work in the cause of education, conferred on him the degree of D.C.L. Another influence in the management of works was his lifelong study of political economy and its influence on manufacturing and commercial problems. His most important contributions to contemporary literature were associated with the application of the principles of political economy to the practical work of the business man, not only in the employment of labour, but in buying and selling. On this subject, as well as on workmen's compensation, the whole position of capital and labour, and the land question, he contributed articles to magazines and various publications. He was naturally brought into close contact with labour problems, and in 1890, when serious difficulties arose between the engineering and shipbuilding workers and their employers, he took a large part, under the lead of the late Colonel Dyer, in the organisation which ultimately became the Employers' Federation. Sir Benjamin Browne's part in the engineers' strike of 1897 will be remembered, and from that time forward he was an active agent in all such labour movements. He was very moderate in his views on the labour question, recognising, as he himself put it, that it was never wise to try and win a victory until every chance of arranging a compromise had been exhausted, so that no bitterness should endure and no reaction be made possible. The Federation movement has certainly, in the broad sense, been conducive to peaceful relationship, because it has enabled agreements and machinery to be evolved which, although they may not work with the highest efficiency and have not eliminated friction, are certainly conducive to amicable settlement. Sir Benjamin took a prominent part in civic and social life. In 1887 he was mayor of Newcastle, and Queen Victoria then conferred upon him the honour of knighthood. He was also deputy-lieutenant and magistrate for the county of Northumberland and the city of Newcastle; he was a J.P. for Gloucestershire. He showed deep interest in all questions connected with crime and pauperism, and in many philanthropic and religious movements. In 1905 he was a member of the Special Committee of the Home Office to inquire into the working of the Workmen's Compensation Act, with a view to further legislation. He was frequently called, also, to give evidence before Royal Commissions on such subjects as the municipalisation of various industries, unemployment, trade unionism, recruiting, and other similar subjects.

He became an associate of the Institution of Civil Engineers in 1864, and was promoted to membership in 1871. He was elected a member of the Institution of Mechanical Engineers in 1902, of the Institution of Naval Architects in 1904, and in 1898–1900 was president of the North-East Coast Institution of Engineers and Shipbuilders.

In 1861 he married the daughter of Mr. R. T. Atkinson, C.E., and had as issue three sons and four daughters, one of his sons being secretary of Messrs. Hawthorn, Leslie and Co., Limited.



[Elliot and Fry, Photo.

THE LATE SIR B. C. BROWNE.

AFTER-WAR PROBLEMS.—During the past few weeks, says *The Canadian Engineer*, some of the important banking and financial institutions of Canada have held their annual meetings. One of the most remarkable addresses delivered on these occasions was that by Sir Herbert Holt, at the annual meeting of the Royal Bank of Canada. Sir Herbert pointed out that the present prosperity had no permanence about it, and that the war was the only thing which had accelerated the wheels of industry; the termination of the war would react on all industry, with very far-reaching results. Factories that were now running full time and overtime and were exclusively engaged in the manufacture of munitions would close. Kindred industries, stimulated by high prices, would suffer by the return of more ordinary conditions. Exports, he anticipated, would decline as Europe imported less, and commodity prices would recede. Labour will become a glut on the market, only to be aggravated by the return of soldiers in large numbers.

THE GERMAN POTASH INDUSTRY DURING THE WAR.—The official quotations of the shares in German alkali concerns at the turn of the year for taxation purposes caused a considerable amount of natural surprise. The prices, on the whole, are much higher than expected, not only higher than at the commencement of the war, but in some cases also than the better values of a few years back. Of 52 concerns, having "Kuxe" or shares, only in half a dozen instances are the prices lower than at the beginning of the war, the rest are higher, and in some cases materially so; in the case of 13 limited companies only two were rated at a lower quotation than in July, 1914. The quotations for the different concerns varied considerably, indicating the material difference in the positions of the works. In not a few instances the higher rate is attributed to the calls made upon the "Kuxe" holders, which in the meantime have been paid, and which, of course, enhance the value of the corresponding lot. The opening out of good deposits has probably influenced the quotation in some cases, and what may be considered favourable combines in others, and of such several have been effected during the war. But the dividends certainly do not justify the taxable quotations, for where dividends at all are paid they are generally on a very modest scale. At the October meeting of the Kali Syndicate the hope was expressed by the board that in the year 1916, with orders then in hand and expected for the remaining two months of the year, an aggregate sale for the year amounting to some 160,000,000 marks (against 193,000,000 marks for 1913) might be anticipated, an increase of more than 50,000,000 marks as compared with 1915. This hope, however, has not come true. The orders received, certainly, leave nothing to be desired, and would have raised the aggregate sale to some 170,000,000 marks, instead of which the actual figure is put between 150,000,000 marks and 155,000,000 marks. As against an estimated sum of 25,000,000 marks for November and December, the actual figure only amounted to 9,000,000 marks for the two months, this shortage being principally attributed to a pronounced dearth of rolling-stock. At the end of December the works had orders on hand which they had been unable to execute, for 70,000 wagon loads. Matters mended during the last two or three days of the old year, when rolling-stock became more plentiful. The Kali Syndicate has recently announced that they have reduced the price per kilogram of pure potash in chloride of potassium to 27 pfennig, although the Government had granted a maximum price of 32 pfennig. The reason for this apparent generosity is a desire on the part of the syndicate to increase the sale of this commodity for home agricultural purposes, whereas it has formerly principally been used for chemical purposes and export. German farmers have hitherto given a preference to 40 per cent. potash manures, which on account of their low price offered material advantages. Owing to developments during the war, the industry has not been able by far to supply the required quantities of 40 per cent. manure.

THE REMODELLING OF AN OLD GRAVING DOCK AT SOUTHAMPTON.

Fig. 1. CROSS SECTION BEFORE REMODELLING.

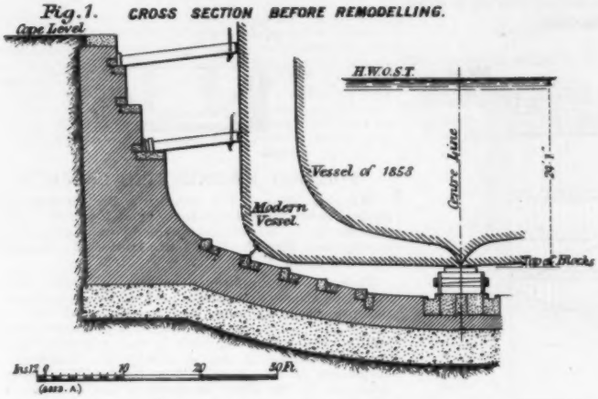


Fig. 2. CROSS SECTION AFTER REMODELLING.

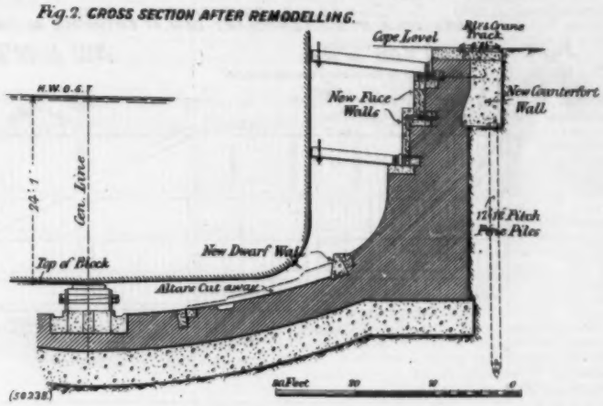
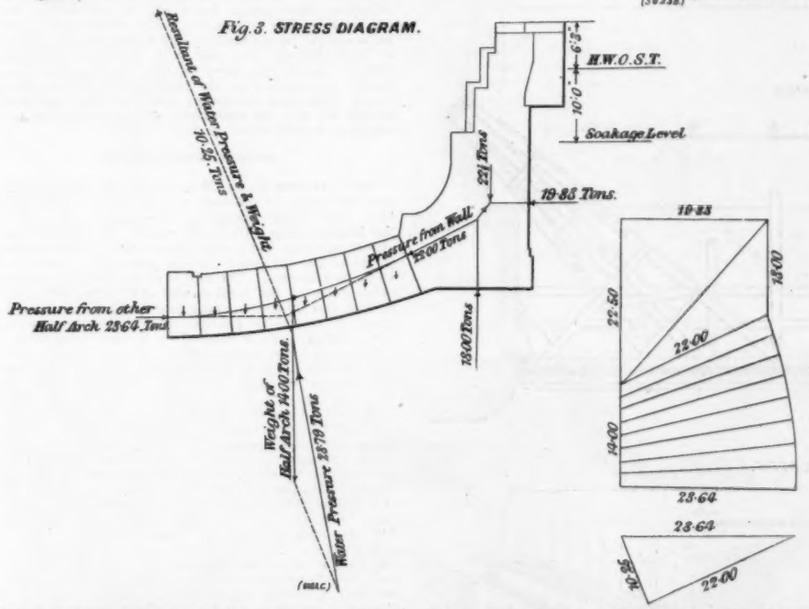


Fig. 3. STRESS DIAGRAM.



THE REMODELLING OF AN OLD GRAVING DOCK AT SOUTHAMPTON.*

By R. N. SINCLAIR, M.C.I.

THE graving dock known as No. 3, which forms the subject of this paper, was built in 1853 from the design of the late Mr. Alfred Giles, Past-President Inst.C.E., and was lengthened to its present dimensions in 1882. It has an inside length of 520 ft. and a width at entrance of 80 ft. The keel blocks are placed at a level of 24 ft. below H.W.O.S.T., the blocks themselves being 3 ft. 3 in. high. From the cross-section (**Fig. 1, on this page**) it will be seen that the walls are 15 ft. thick at the base, and that they are reduced by means of three sets of altars to a thickness of 5 ft. at the top. The floor has the shape of an inverted arch, and formerly contained five small altars or steps on each side. The walls are constructed of brickwork in lime mortar. The floor consists of the same material for a thickness of 4 ft., and below that of a similar thickness of lime concrete. There are no precise records of the nature of the subsoil on which the dock is placed, but there is no doubt that it consists either of a weak sandy clay or of a fine running sand, both of which strata prevail in this neighbourhood.

During the period intervening between 1853, when this dock was built, and the present time, a great change has taken place in the design of ships. Fig. 1 shows the midship sections of two vessels which illustrate this change. A corresponding change has had to be made in the shape of dry docks.

No. 3 graving dock at Southampton was, however, designed to take the old-fashioned ship, and when the more flat-bottomed vessels were introduced it was found almost impossible to get them in and out of the dock unless the keel blocks were raised. This meant that such ships could only pass in at very high tides and that deep-draught vessels could not go in at all. In order to make the dock once more available for modern ships it was decided to flatten the floor by cutting away the haunches of the inverted arch, as shown in cross-section, Fig. 2.

Before doing this, however, it was necessary to ascertain how the strength of the whole of the structure would be affected by the proposed alteration. The effect of cutting away the haunches of the floor would be twofold. In the first place the thickness of the arch would be reduced and the arch itself consequently weakened; and in the second place the weight of the floor would be reduced, and therefore the tendency of the whole structure to lift would be increased. It was decided, therefore, to cut away the floor only to the limited extent shown on Fig. 2, as it was considered that this could be done with safety.

An experiment was made to find out the actual upward pressure of the subsoil water beneath the floor. Two small holes were drilled through the whole thickness of the floor, one at each end of the dock to the sand beneath. A pressure gauge registered the pressure of the water inside the borehole when the sand was reached. Readings were taken every hour for 24 hours, and it was found that the pressure stood steadily at 7 lb. per square inch at the south end and 5 lb. per square inch at the north end. The pressure did not seem to be affected by the rise and fall of the tide. The larger pressure, 7 lb. to the square inch, corresponds to a soakage level of 10 ft. below H.W.O.S.T. This was assumed, therefore, to be the level from which pressure head should be measured. Fig. 3 shows a stress diagram in which half the floor arch, as cut away, is considered to be in equilibrium under four loads, viz., its own weight, the upward pressure of the subsoil water as found above, the horizontal pressure from the other half of the arch, and the inclined pressure from the wall. The centres of the two latter pressures being assumed to act at one-third points, the maximum pressure on the masonry is found to be 5¼ tons per square foot. It was considered that even the lime concrete, locked in as it is by firm ground and good brickwork, ought to be able to bear this pressure safely.

As regards the loss of weight on the floor, it was of course an easy matter to compensate for this, and the method adopted is shown on Fig. 2. The principal compensation took the form of a counterfort wall built at the back of the existing wall. Additional weight was also provided by thickening out the two altar walls.

It will be seen from the cross-section, Fig. 2, that the cutting away extended from a point 12 ft. from the centre of the dock to the floor altar at the foot of the wall. The new counterfort wall at the back of the old wall was made of 6 to 1 Portland cement gravel concrete, 4 ft. to 5 ft. 6 in. wide and 8 ft. deep. It rested partly on timber piles driven at intervals of 10 ft., and partly on a special benching cut in the back of the wall. The top of it was tied on to the existing wall by 1¼-in. steel ties 5 ft. apart; these ties passed through the wall and were hooked into the new altar walls.

The works were commenced in January, 1914, but owing to the necessity for keeping the graving dock in constant use they have been frequently interrupted.

A long interval elapsed owing to the dock being in constant use, and then in February, 1916, a start was made with the cutting away of the floor, the dock being handed over to the engineers for that purpose. The cutting away was all performed by labourers with hammers and points. The new floor altar walls and upper altar walls were built behind shuttering. The work was completed in September, 1916, the dock being closed to traffic for a period of seven months.

Repairs to Gates and Sill.—As mentioned above, the dock was closed with a pair of wrought-iron gates. These are probably over 60 years old, and although they had been repaired from time to time they had got into a bad state. While repair was under consideration an accident occurred to the masonry of the sill, against which the gates rested. It necessitated the immediate erection of a dam at the extreme north end of the dock so as to admit of the entrance being dried out, and repairs to the sill, and incidentally to the gates, to be put in hand.

Temporary Dam.—The type of dam adopted consisted of a single floating gate made of timber and strutted with the same material. This type was adopted in preference to any sort of pile dam, because it was cheap, and, moreover, it could be easily removed and used again when the time came for renewing the dock gates.

The dam is shown on Figs. 4 and 5, page 135. The gate consists of a sheeting of upright pitch pine 13-in. timbers bolted to five lines of horizontal walings. Four of the latter consist of three whole timbers inside the dam and one outside. These walings were connected on the inside of the gate by six vertical timbers and on the outside by two diagonal timbers, to prevent racking. The gate was, of course, cut as accurately as possible to the shape of the entrance of the dock, and all round the edge of its face was fastened a line of padding formed of canvas tubing filled with oakum. This served to ensure a watertight joint between the gate and the stop against which it rested. This stop consisted of a step in the brick floor, which fortunately had been constructed at the mouth of the dock by its builders. To enable the gate to float upright, when being placed, it was ballasted with Portland cement concrete filled in between the fourth and fifth lines of walings, and further to secure it from floating up after it had been placed in position a timber trough was built on the top of it which was filled with gravel. The gate was prevented from collapsing from the outside pressure of water, partly by the stops and partly by eight lines of angle struts made of Oregon pine timbers about 16 in. square. The longer struts were connected together by vertical and horizontal bracing to prevent their buckling under the heavy load which they had to support. The outer ends of these struts rested in notches cut into the gate walings, to which they were strapped and bolted, the other ends rested against vertical timber footings which were placed in large V-shaped notches purposely cut into the dock walls.

While the gate was being built the two V-shaped notches were cut in the gate recesses, and the footing timbers described above were fastened into them.

As these notches projected many feet below low tide a limpet dam was used to exclude the water while cutting them. This is shown on **Fig. 6.** It consisted essentially of a box containing three sides and bottom sufficiently stiffened and ballasted. The box was placed against the wall to be cut away in such a position that the wall formed the fourth side of the box. On pumping out water from the box the latter was of course pressed against the wall by the weight of water outside it.

Repairs to Gates.—As mentioned above, the dock-gates were probably over 60 years old. They are shown to

* Abstract of paper read before the Concrete Institute on February 22, 1917.

THE REMODELLING OF AN OLD GRAVING DOCK AT SOUTHAMPTON.

L & S.W.R. SOUTHAMPTON DOCKS:
DRY DOCK No 3: TEMPORARY DAM AT ENTRANCE AS CONSTRUCTED.

Fig.4.

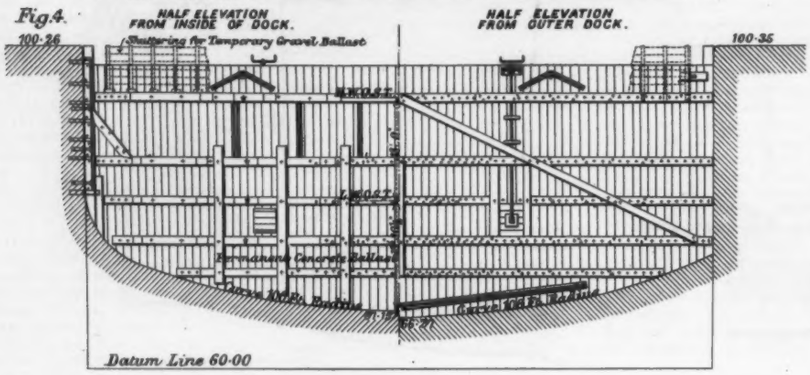


Fig.5. PLAN OF TOP WALINGS

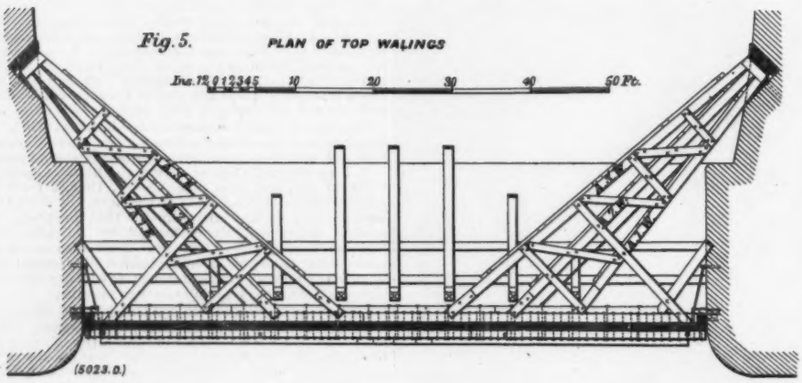


Fig.7. REPAIRS TO GATES.

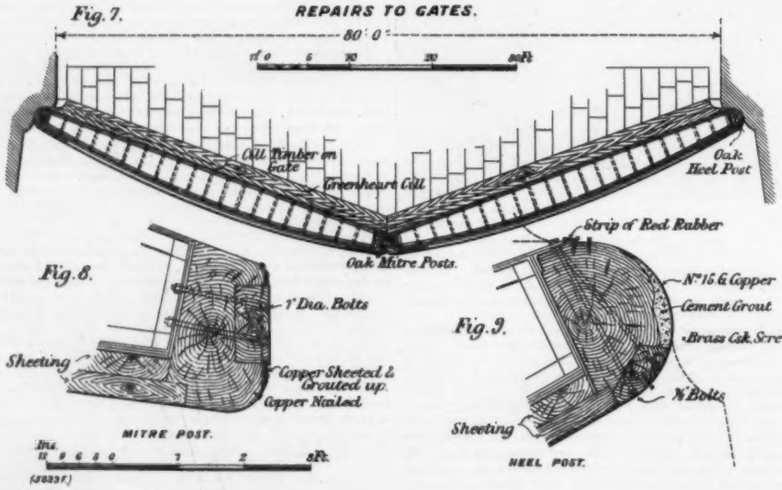


Fig.8.

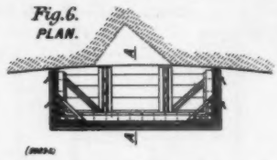
Fig.9.

some extent on Fig. 7. They were built for the most part of wrought iron, the decks and inner skin, with the end stiffeners, being constructed of this material. The outer skin was formed of two layers of 4-in. fir planking. The heel and mitre posts were of oak and the sill timbers of greenheart. The outer thickness of the timber skin was eaten away to some extent by marine insects, so it was covered with a third thickness of 1¼-in. fir planking.

The greenheart sill timber was in good condition, and nothing was done to it beyond refacing it. The worst deterioration was in the oak heel and mitre posts. The latter were badly eaten by marine insects below low water, so much so that they no longer touched when the gate was closed, but showed a gap of over 1 in. They were repaired by attaching two new oak face-pieces about 14 in. wide and 6 in. thick. These were housed into the old posts and bolted through to the ironwork of the gates. One of the heel posts was also badly eaten. This was repaired partly in the same way, viz., by cutting out the damaged parts and bolting on a new timber. At the back of the post, however, this could not be done, as the post rested in the hollow quoins and was not accessible. It was therefore repaired by covering it with copper sheeting $\frac{1}{16}$ in. thick, passed right round the post and screwed to it. Cement grout was afterwards poured in between the copper and the wood to fill the voids eaten away by the insects. It is interesting to note that while both the fir and the oak were badly attacked by these insects, the greenheart was quite unaffected. This is in accord with the experience of other structures in sea water at Southampton.

It was, of course, realised that these repairs, being of a patchwork nature, could not ensure an absolutely watertight fit between the heel posts of the gates and the hollow quoins against which they pressed. Accordingly, to minimise leakage, a strip of indiarubber, 3 by ¾ in., was let into and screwed on to each heel post from high-water level down to the bottom of the gate. The effect of this has been excellent, and the leakage through the gates, which formerly amounted to over 500 gallons per minute, has been diminished to about 150 gallons per minute.

Fig.6. PLAN.



FOREIGN ENGINEERING PROJECTS.

WE give below a few data on a French engineering project, taken from the *Board of Trade Journal*. Further information on this can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

France.—With reference to the industrial developments at Caen (Normandy) and, more particularly, to the projected widening and deepening of the canal from Caen to the sea, the British Vice-Consul at Caen reports, under date February 9, that a Decree has been issued declaring of public utility the widening and deepening of this canal. The British Vice-Consul is informed by the Chief Engineer of the Department of Calvados that foreign firms will be allowed to tender for work in this connection. The conditions of tender have not yet been drawn up—the preliminary acquisition of land having not yet been effected—nevertheless British contractors who, in due course, may wish to tender are invited by the engineer-in-chief to get into touch with him, informing him on what terms they would be able to undertake the construction of the whole or part of these works.

THE LARGEST PLATE MILL IN THE WORLD.—There is now in course of erection in the works of the Lukens Iron and Steel Company, Coatesville, Pa., U.S.A., the largest plate mill in the world. It will be capable of rolling plates 16 ft. wide, from which it will be possible to make flanged heads in one piece for marine boilers 15 ft. in diameter. The mill is of the two-high reversing type, each of the chilled cast-iron rolls being 34 in. in diameter with a working face of 17 ft., and weighing about 30 tons. To prevent these rolls springing under the pressure each is backed by a steel supporting roll 50 in. in diameter and weighing 60 tons. Both cast-iron rolls are driven, and, in addition, the lower steel roll is also driven through a friction coupling. The upper rolls are screwed down by worms and worm wheels, each driven by a 150-h.p. electric motor. The complete mill will be about 42 ft. in height and about 70 ft. in width over the pinions. It will be driven by a twin tandem compound engine, having cylinders 46 and 70 in. in diameter by 60-in. stroke, constructed by the Mesta Machine Company, Pittsburg. It is estimated that the mill will be able to turn out about 3,000 to 4,000 tons of plates a week. Six new basic open-hearth furnaces of 100 tons capacity each are being laid down. The main mill building is 70 by 215 ft.; the cooling building is 100 by 240 ft.; the shearing building, 80 by 240 ft.; and the shipping-house, 90 by 500 ft. The design of the mill is jointly due to the engineering staffs of the United Engineering and Foundry Company and the Lukens Iron and Steel Company.

POTASH FROM CEMENT MILL DUST.—The successful operation of the dust precipitation, by the Cottrell process, in the Riverside Portland Cement Company, California, last year, induced the Security Cement and Lime Company, of Hagerstown, Maryland, to adopt the system, and according to the account given by Mr. Arthur C. Hewitt, chief engineer of the company, in *Engineering News* of December 28, 1916, the special aim in view, recovery of the potash from the dust, has been realised, and the operations have profited on the whole by the improved methods introduced at the same time. There are five kilns, two small and three large ones, and the dust "treaters" are in four separate units. The hot gas and dust from the kilns are sucked through steel tubes, while walls and axial wires form the electrodes for the precipitation. The four treaters are erected in a special house, practically a steel building, the steel and tubes being earthed. There are altogether 800 tubes, 15½ ft. high, 1 ft. diameter, bolted below and above to steel plates; the axial wires, loaded below, are suspended from wooden frames; the insulators consist of a Californian marble, the only material which has answered. The heat insulation is by asbestos. Motor generators and disc rectifiers send currents at 70,000 volts to the wires. The dust settles both on the tube walls and on the wires; both are vibrated by means of hammers. Owing to the war there was considerable difficulty in obtaining the steel tubes, and the erection of the plant in the dusty atmosphere of the mill, especially after installation of the first high-tension unit, was a severe task for the men. There was trouble at first also owing to short circuits between the wires and tubes, which must be smooth inside, and the staff were not accustomed to maintaining a steady temperature in the kiln by means of pyrometers; this is necessary for securing a gas velocity through the tubes of 3 or 4 ft. per second at about 900 deg. F. The very fine dust collected, about 20 tons per day, contains up to 10 per cent. of K_2O as sulphate, and is sold as fertiliser. The first unit has been working since June, the others since July, 1916.

A GERMAN CRITICISM OF BRITISH SHELLS.

An officer in the German Army, who is, in his civil capacity, an engineer (Dr. Gümbel), stationed at present on the Somme, has conducted an investigation on the splinters of our high explosive shells, the result of which he communicated to the organ of the German engineers.* He makes the observation that notwithstanding the great diversity of the many fragments he handled and examined they all conform in one respect, and that is the angle which the fractures form with a plane perpendicular with the axis of the shell. These angles were measured by such means as were available in the trenches, and were found to be $\pm$ 45 deg. The surface of the fractures showed in all cases that the break resembled that produced by shearing action. A simple investigation demonstrates the law of this phenomenon.

If the cylindrical part of a shell of the thickness s and the radius r is exposed to an internal pressure p, each particle is subjected to the pressure $K_2 = \frac{r\,p}{s}$. The component $r\,p \sin \alpha$ of the force $r\,p$ represents the shearing force acting on the section $\frac{s}{\cos \alpha}$ (Fig. 1). The additional shearing stress is, therefore (if we assume the radius of the shell to be infinite) (Fig. 2)

$$K_1 = \frac{r\,p \sin \alpha \cos \alpha}{s} = \frac{r\,p \sin 2\,\alpha}{2\,s}$$

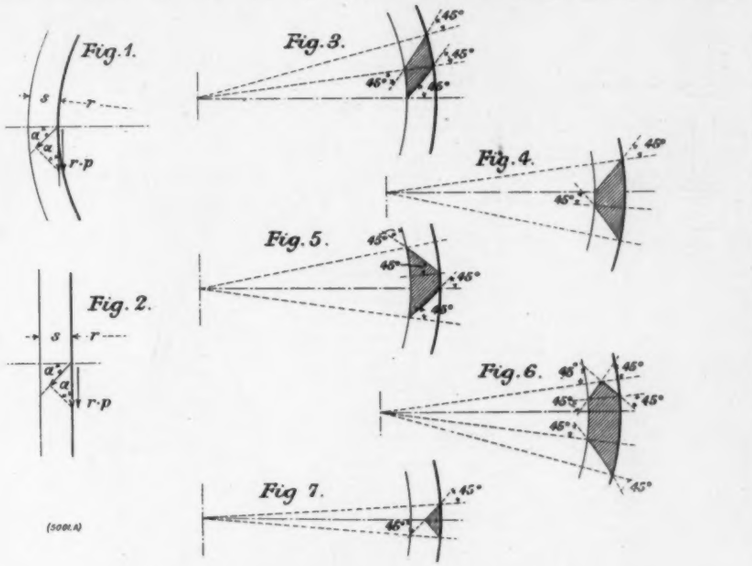
The maximum value of K_1 thus corresponds to an angle of $\pm$ 45 deg.

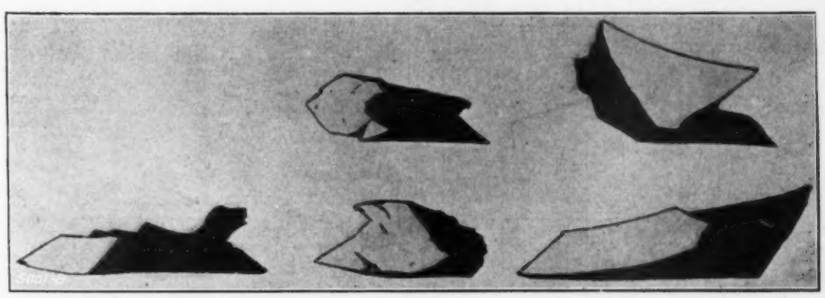
As this applies to any diameter and any point of a shell, the angle of $\pm$ 45 deg. will be the same for all fragments of the shell during the progress of rending.

With the progress of the rend r and s change, and the separation follows a logarithmic spiral, the formula of which is $r = r_0\, e^{\phi}$, when $\phi = 0$ and $r = r_0$ (see Figs. 3 to 7).

The rending and splitting in a radial direction which one might be led to expect, and which takes place in cast-iron shells, does not occur in shells of ingot iron (steel), owing to a certain elongation of this material prior to fracture. The destructive nature of shells made of ingot iron (steel) must be attributed to the knife-edged form of the fragments.

The photographic reproductions in Figs. 8 and 9 of fragments found in the Somme district confirm the above observations. The fragments have been ground in a plane perpendicular to the axis of the shell in order to determine the angles.





FIGS. 8 AND 9.

* *Zeitschrift des Vereins deutscher Ingenieure*, December 9, 1916.

THE COMMERCIAL METERING OF AIR, GAS AND STEAM.*

By JOHN LAWRENCE HODGSON, B.Sc., Assoc.M.Inst.C.E.

THE paper first discusses the various bases which are suitable for the measurement of compressed air supplied in bulk, and emphasises the desirability of measuring in energy rather than in weight or volume units. The basis of measurement adopted by the Victoria Falls and Transvaal Power Company and by the Rand Mines, Limited, was the quantity of air which would be compressed from mean atmospheric pressure and temperature on the Rand to the pressure of delivery by the expenditure of the energy represented by 1 kw.-hour in an isothermal compression process of the same overall efficiency as that which obtained between the indicated power in the steam cylinders and the air delivered in the case of certain specified compressors then in use upon the Rand, it being understood that these compressors should be put in first-class order for the purpose of the test, and run under normal conditions as regards speed and pressure.

Descriptions of the meters and overload devices designed by the author for use in connection with the Victoria Falls and Transvaal Power Company's air-supply scheme on the Witwatersrand are then given. Two types of meter were used in connection with this scheme; in that supplied to the Power Company a Venturi tube was used, and in that supplied to the consumers a weighted gate placed in the air-way.

The more interesting parts of these meters are described, including the arrangements, whereby the various factors upon which the energy required to compress the air delivered at each point of supply depends, are measured and combined so as to give a counter and diagram record of the energy passing; the bell, which is sensitive to a Venturi head of less than one ten-thousandth lb. per square inch and which will measure Venturi heads up to 0.85 lb. per square inch; the pressure diaphragms, by means of which a powerful movement is obtained from a small change in the pressure; and the air-driven centrifugal escapement, by means of which the integrating gear is accurately timed.

Two types of overload device are then described; the one cutting off the flow if the maximum discharge contracted for is exceeded; the other throttling the discharge when necessary, to limit it to the maximum contracted for. These overload devices are so arranged that they can readily be set to cut off or to regulate (as the case may be) at various maximum flows within their range. The illustrations given include diagrams of the various parts referred to, and of a typical meter installation on the Rand.

The paper next describes the testing plant, which was specially built for calibrating these meters by Messrs. Fraser and Chalmers to the specification and under the supervision of Mr. A. M. Robeson, Mr. A. Smart, and the author, and which is now re-erected at Ferriera Deep on the Witwatersrand and forms the standard air-testing plant for South Africa. Details are given of the large displacement meter which forms part of this plant, and which is capable of passing 1,200 lbs. weight of air per minute, and of the precision manometer, by means of which differential pressures can be measured over a large range to within one one-thousandth inch head of oil.

The relation between liquid and gaseous discharges through the same nozzle is then discussed, and it is shown, for various typical nozzles and orifices, how the gaseous discharge can, under certain conditions, be calculated if the liquid discharge is known. A table is given which shows how the economy in the power required for testing meters or wind-resistance models diminishes with the density of the fluid used. The importance of designing the discharge nozzles of "fair shape," if the theoretical discharge formulas are to be used to obtain the discharge, is emphasised.

The results of the author's experiments on the variation of the discharge coefficient for different types of nozzles and orifices for various values of the ratio of the upstream to the throat pressure are stated. The experimental discharge coefficient for square-edged orifices placed in a bored pipe-line is given, and the necessity for the careful placing of the pressure holes, and for geometrical similarity, is emphasised. A set of curves which show the rapid variation of the pressure of the fluid in the vicinity of the orifice is given. The work on square-edged orifices was carried out by the author in order to obtain an easily reproducible standard of air measurement, but he prefers to use round-edged orifices for commercial work on account of their smaller liability to be damaged by erosion or careless handling. The difficulties met with in measuring pulsating flows by means of nozzles and orifices are next discussed, and tables are given which show for three typical wave-forms of various amplitudes, and for two different laws of damping, the nature and the approximate amount of the error likely to occur in the measurement.

Other meters described are:—(1) A meter by means of which pulsating flows of any wave-form and amplitude may be accurately measured. (2) A meter designed by the author for general mining work. This is extremely simple in construction, and is easily handled and installed and maintained. It can be arranged to register in weight, volume, or energy units, as required. It will measure such pulsating flows as are met with in practice with sufficient accuracy, and it corrects automatically for variations in pressure. (3) A steam-metering instrument designed by the author. (4) A gas meter which has been very successfully used for the metering of large volumes of gas. It will measure down to one-twelfth of full load, and, unlike all other gaseous meters which depend upon a differential pressure measurement, the registration of this meter is independent of the density of the gas passing.

The paper is accompanied by an Appendix, in which the necessary calculations and theory are given.

* Abstract of a paper read at the ordinary meeting of the Institution of Civil Engineers, on Tuesday, March 6, 1917.

FRENCH RAILWAY TARIFFS.—We read in *L'Exportateur Français* that the deficit on the French railways for 1916 amounts to a total of 380,000,000 francs (£15,200,000). In order to meet this our contemporary urges the French public to consent readily to an increase in the railway tariffs, on the plea that the railways are commercial companies who sell their commodity, namely transport, in the same way as any other commercial enterprise sells its own. Owing to the increase in the cost of coal and rolling-stock, an increase in railway tariffs is quite justified.

AMERICAN RAILWAY RESULTS.—The Bureau of Railway Economics, Washington, says the *Railway Review*. Chicago, has compiled the revenue and expenditure of steam railways in the United States for November, 1916. The compilation covers 230,884 miles of lines, or about 90 per cent. of the steam railway mileage of the United States. The operating revenues averaged $1,396 per mile, an increase over November, 1915, of 7.2 per cent. The operating expenses per mile were $894, an increase of 11.7 per cent. The net operating revenue per mile, $502, showed a decrease of under one-tenth of one per cent.; whilst the net operating income per mile, $441, showed a decrease of $8 or 1.8 per cent. The November, 1916, operating income per mile—1.8 per cent less than in November, 1915—was 81.1 per cent. greater than in 1914; 54.1 per cent. greater than in 1913, and 21.4 per cent. greater than in 1912. Taxes per mile rose 15.1 per cent. as compared with the same month of last year.

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The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

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Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

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Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

ELECTRICAL APPARATUS.

14,423/15. Marconi's Wireless Telegraph Company, Limited, and I. Shoenberg, London. Transformers. (2 *Figs.*) October 12, 1915.—It is well known that if a transformer be so designed that the magnetisation of the iron core is carried beyond the "knee" of the curve, a deformed secondary current may be produced having pronounced harmonics. According to this invention, a rotating magnetic field is produced in the closed core of such a transformer having a number of secondary coils around the core and connected in parallel. In Fig. 1, A is a three-phase generator connected to the primary winding of a transformer B, so designed that the magnetisation is carried beyond the knee of the curve. C^1, C^2 . . . C^n are secondary coils spaced round the core in such a way that the difference of phase between the currents in any two consecutive coils is constant, and connected in parallel to leads D, E. Transformers may, if desired, be inserted between A and B. In Fig. 2, A is a three-phase generator connected to the primary winding of a transformer B, having secondaries C^1, C^2 . . . Cn. These

Fig. 1.

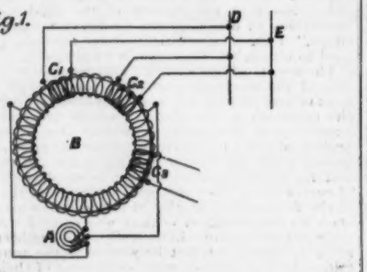
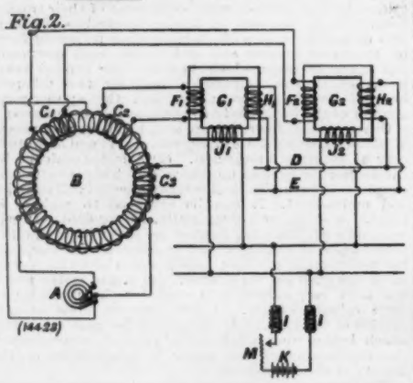


Fig. 2.



coils are connected to the primaries F^1, F^2 of *n* transformers G^1, G^2. The secondaries H^1, H^2 of these transformers are connected in parallel to leads D, E, and the transformers are provided with third windings J^1, J^2, which are energised from a source K of direct current through large choking coils I, I, and a resistance M. From the common leads D, E a current can be taken, the frequency of which will be the *n*th multiple of the fundamental frequency as determined by the generator A. The change of frequency is effected in the following way:—The cores of the transformers G^1, &c., are saturated by means of the source K so as to be above the knee of the magnetisation curve. The degree of saturation will have to be chosen (up to a certain extent) in accordance with the number of coils, as well as with the phase difference on the common terminals of the coils C^1, &c. Owing to this saturation the currents in the coils H^1, &c., get distorted or, in other words, are made to possess even harmonics. Since all these coils are connected in parallel, all harmonics will be destroyed except the one of which the order is given by the number of coils. (*Accepted December* 20, 1916.)

102,662. W. T. Henley's Telegraph Works Company, Limited, London, and E. E. Judge, Gravesend. Electric Coupling Members. (2 *Figs.*) March 30, 1916.—This invention relates to quick-break electric couplings. In a coupling constructed according to this invention, the main blade is secured to a removable carrier, such as is employed as a fuse carrier, and is adapted to be inserted between two pairs of contact pieces, the said main blade having on its face a pair of auxiliary blades, each of which is pivoted at its inner end to the main blade and is connected therewith near its outer end by a spring. The coupling illustrated is provided with a carrier *a*, of the kind used as a fuse carrier, to which is secured the main blade *b* of the coupling. The blade *b* is recessed near each end at *e* for the accommodation of a coiled spring *d*. The springs *d* are connected at their opposite ends with the blade *b* and with the free outer ends respectively of a pair of auxiliary blades *c*, *c*, each of which is pivoted at its inner end to the main blade *b* near the centre of its length, and is recessed as at *f* near its outer end for the accommodation of the spring *d*. The carrier *a* is constituted by a porcelain body, provided at that face which is opposite the blade *b* with a handle *m*, whereby it may be conveniently grasped when it is desired to open the coupling, and the said body is recessed to receive the main and auxiliary blades *b*, *c*, *c*, and is provided at each end with lateral wings *o*, *o*, which, when the coupling is closed, shield the contact pieces *p*, *p*. When it is desired to open a coupling, the handle *m* of the carrier is grasped and the whole is pulled bodily away from the contact pieces *p*, *p*. The strength of the springs *d*, *d* is less than the frictional resistance between the sides of the auxiliary blades *c*, *c* and the contact pieces *p*, *p*, so that as the main blade *b* is withdrawn the auxiliary blades *c*, *c* remain in

Fig. 1.

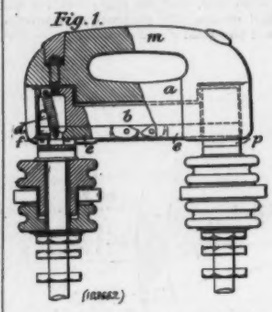
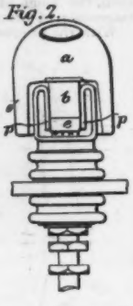
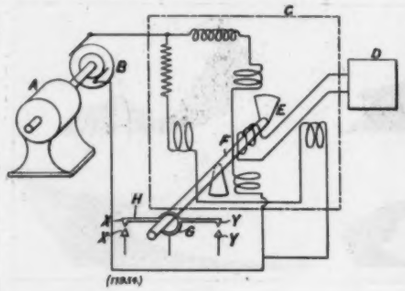


Fig. 2.



position between the pairs of contact pieces *p*, *p*, until the main blade *b* is wholly withdrawn, when they carry the current until such time as their bevelled inner ends come into contact with the face of the main blade *b*, thus preventing further angular movement, when the pull of the handle *m* will overcome the frictional resistance between the auxiliary blades *c*, *c* and the contact pieces *p*, *p*, and withdraw the former from between the latter, the action of the springs *d*, *d*, which are then permitted to restore the auxiliary blades *c*, *c* to normal position on the face of the main blade *b*, serving to expedite the rapidity of the break, as will be understood. (*Accepted December* 29, 1916.)

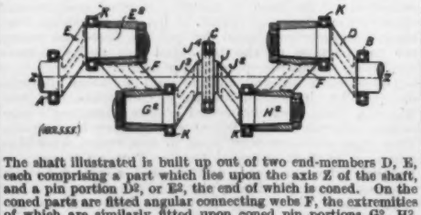
17,954/15. Marconi's Wireless Telegraph Company, Limited, and C. S. Franklin, London. Controllers. (1 *Fig.*) December 23, 1915.—The object of this invention is to provide improved means for controlling and keeping constant the speed of any machine which it is desired to run at a particular speed. According to the present invention, a special form of relay in connection with a control source of alternating current is provided, and an alternator is connected to the machine for the purpose of actuating control apparatus. A is the machine to be controlled, to which is coupled a small alternator B. D is a source of alternating current of very constant frequency. C is a synchroscope relay having two independent windings connected to B and D respectively. E is the rotor, which rotates with a



speed equal to the difference of the frequencies supplied by D and B, the direction of rotation being determined by the higher or lower frequency of B as compared with D. The spindle F of the rotor E is then connected by a clutch, such as a friction ring G, to an arm H, so arranged that it closes contacts X, X or Y, Y in accordance with the direction of the movement of the rotor. These contacts will be included in circuits arranged to actuate some form of apparatus controlling the power supplied to the motor driving the machine A, and so arranged that the power supplied is reduced when the machine is running too fast, and *vice versa*. These controlling arrangements are not shown in the diagram, as obviously they will depend upon what kind of motor is driving the machine A. (*Accepted December* 29, 1916.)

GAS-ENGINES, PRODUCERS, HOLDERS, &c.

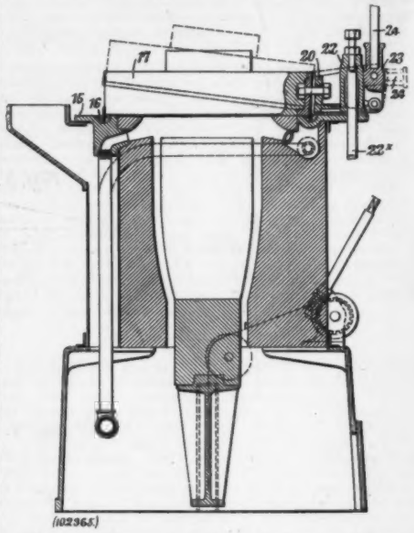
102,555. G. St. B. S. Watkins, Lewes, and G. Funck, Coventry. Crankshafts. (2 *Figs.*) March 22, 1916.—It is the object of the present invention to construct a shaft of the minimum length with adequate bearing surface and great strength for its weight. Accordingly, narrow ball or roller bearings are employed on both the shaft and the pin portions, and wide angular webs, preferably of channel or similar section, are detachably fitted to the pins. The end bearings are shown at A, B, and at the centre the shaft is supported upon a bearing at C.



The shaft illustrated is built up out of two end-members D, E, each comprising a part which lies upon the axis Z of the shaft, and a pin portion D^2, or E^2, the end of which is coned. On the coned parts are fitted angular connecting webs F, the extremities of which are similarly fitted upon coned pin portions G^2, H^2, formed at the ends of a central member J, which comprises two webs J^3, J^3, and an axial part J^4, which carries the central shaft bearing C. Upon each pin portion is mounted a narrow bearing K. Thus, out of the total length of the crankshaft between the end bearings A and B, only a very small part is occupied by the intermediate bearings C and K. Consequently by far the greater part of the crankshaft length can be devoted to the webs, which are of angular shape, as shown, and may be hollowed or channelled out as indicated by dotted lines for the sake of lightness. (*Accepted December* 20, 1916.)

MINING, METALLURGY, AND METAL WORKING.

102,365. J. Keith and G. Keith, London. Crucible Furnaces. (2 *Figs.*) June 22, 1916.—This invention provides a convenient arrangement for tilting the cover or lid clear of the furnace casing, to permit it to be swung horizontally to one side. Characteristic of the invention is the employment of a lever co-operating with a cam for tilting the cover and also serving as a means for effecting the horizontal movement. The furnace cover 17 is fitted with a collar arranged to dip into a sand lute 16 in an annulus 15 constituting a flange on the upper end of the furnace casing. The cover 17 is arranged to tilt upwards, to swing clear of the lute and the top of the furnace. The frame of the cover 17 is attached loosely by means of a bolt to a casting 20,



which is hinged to a casting 22 rotatable around the fixed spindle 22*x*. For tilting the cover 17 there are provided the cam 23 and lever 24. It will be seen that when the lever 24 is moved into the horizontal position shown in the dotted lines, the cover 17 will be tilted upwards, into a position such that it can be conveniently swung in the horizontal direction by actuation of the lever 24. The arrangement is such that, in the raised position of the cover, the bolt is in tension and the lower part of the cover bears on the extension formed on the casting 20. It will be seen accordingly that when the cover is swung open it can easily be reversed by revolving it on the bolt, so that the refractory material of the cover can be repaired or renewed conveniently. (*Accepted December* 6, 1916.)

MISCELLANEOUS.

102427. Sir W. G. Armstrong, Whitworth and Company, Limited, and W. Thompson, Newcastle-upon-Tyne. Hose Pipes. (4 *Figs.*) April 5, 1916.—The object of this invention is to provide a tool by which a wire binding may be quickly applied to the outside of a tube, such as a hose pipe, to secure it to a connection. A tool, constructed in accordance with this invention, has two jaws, one of which, A, is fast with a handle B, and the other, C, hinged to it. The hinged jaw carries a screw E, by means of which it may be forced away from the fixed jaw. The fixed jaw has two holes F bored transversely through its end, and the hinged jaw has two lateral grooves G, one on either side, near its end, so that when the two jaws are close together one groove lies opposite each hole. Hinged at H to the jaw A is a cutter-arm I, having in it two holes J, which register with the holes F when the arm I is in the position shown. The method of applying a wire binding to a tube or pipe is as follows:—Two loops K are formed in a length of wire, the two ends L lying on

Fig. 1.

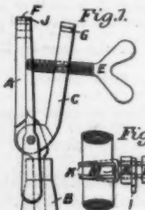
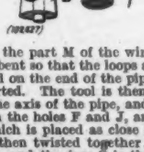


Fig. 2.



the same side of the part M of the wire between the two loops. The wire is then bent so that the loops are co-axial, and the loops are then threaded on the end of the pipe O into which the union or nozzle is inserted. The tool is then held with the jaw A at right angles to the axis of the pipe, and the ends of the wire are threaded through the holes F and J, and through the grooves G in the jaw C, which is placed as close as possible to the jaw A. The ends L are then twisted together so that they cannot pull through the tool, and the jaw C is then forced away from the jaw A, thus tightening the loops of wire; when they are sufficiently tight the tool is turned round the pipe, that is, anti-clockwise (as viewed in Fig. 1), the top of the jaw A bearing upon the pipe. The ends of the wire are thus bent round the portion M. The cutter-arm I is then pressed towards the handle B, and the wires are thus sheared between the jaw A and the arm I. The tool is removed and the ends of the wire which were in the holes F are knocked down on to the pipe. (*Accepted December* 13, 1916.)